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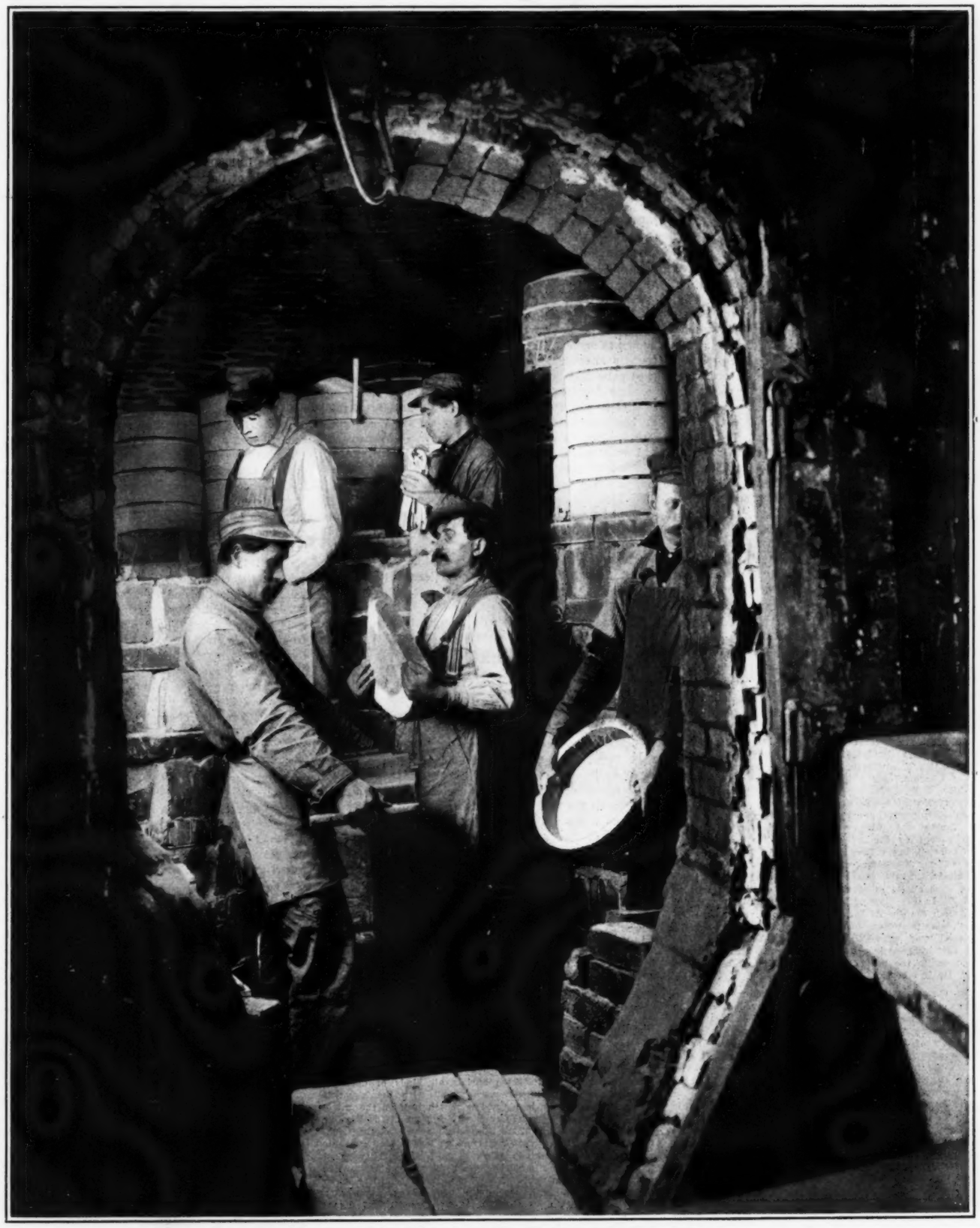

¶ Loading a vitrifying kiln with grinding wheels enclosed in saggars

MODERN ABRASIVE WHEELS—[See page 120]

The Religion of Ancient Ukraine*

In the Light of Archaeology and Folk-lore

WHERE an antiquity, an ancient human existence, has left documents and some clue, however faint, to its old form of life, one can re-create, as from the papyrus and the sarcophagi of Egypt, a people and in our imagination the dead past lives again.

But when we leave Egypt with her pyramids and think upon "the forgotten kingdom of Ukraine" we may dream above her wild steppes, above the yellow waves of the Dnieper and ask ourselves—in vain—what was happening in this land in the same period, when Egypt's culture reached its highest mark. The Ukraine is silent as its own grave-hills, with which its expanse is covered. The ancient Ukrainians did not leave pyramids, nor records on papyrus, nor granite sarcophagi. Yet if we would know their past they too can be made to speak with lips of dust.

Archaeologists have excavated practically all of the grave-hills left unviolated by robbers and they have found rooms in the higher parts of the barrows. A skeleton of a man would be lying in the funeral chamber; beside it bones of horses, the fragments of saddles, harness with golden ornaments, earthen and golden vessels, rings, necklaces of precious stones. In the southern Ukraine, in the Zaporogian steppes, grave-hills have been excavated which disclosed to view articles made in Greece hundreds of years before Christ.

Herodotus, the first Greek historian known to us (490 B. C.), describes these people, whose bones we have now disinterred, and calls they Scythes (Scythians).[1] He says that they were nomads, most of their life probably being spent in the saddle. Excelling as archers, they wandered over the wild steppes of the Southern Ukraine a people without any knowledge of writing.

Digging deeper in the Ukrainian grave-hills archaeologists found still another evidence of burial. Here there was but one skeleton with fragments of stone weapons. This excavation showed that before the Scythian age another people, less civilized than the Scythes, had existed—"the man of the stone age," as he has been found in other lands. And this is all that the grave-hills can tell us.

And that is so little! We want to know—we are eager to know—what the ancient Ukrainian was thinking, what was his conception of the universe, whom did he worship? But here the grave-hills are silent. It is true that upon some graves granite figures of Scythian workmanship were found, known as "Old Women." They were simply-sculptured images of men, sometimes six feet tall, placed on top or on the side of the grave-hill. But there is no evidence at all that these figures were images of some Scythian god. Rather would such seem to be the gravestones of buried chieftains. But, owing to the fact that these "Old Women" were found only in the southeastern part of the Ukraine—on the steppes where in the twelfth century Polovtzi (Mongolian tribes) appeared, and, in the thirteenth century, Tartars—some have thought that these figures were placed there by Mongolians, and are their gods. This theory, however, is not generally accepted.

Herodotus tells us that a Scythish chieftain, when Darius invaded the Ukraine, sent a notice to the latter telling him that he and his army should perish if the king attempted to enter "the land of the ancestors' graves." This is another proof that in the time of the Greek historian Scytho-Iranian tribes had the cult of ancestors and believed in a future life.[2]

The man of the stone age in the Ukraine left very few clues to his mode of life—some flint spears and roughly-made earthen vessels only. Probably he was a type of the primary inhabitants of Europe, like the Finns. What happened to this people in the Ukraine is unknown. But it is plain that from Asia, from Ariastan (Iran), another race followed, who heaped their grave-hills upon the graves of the primeval inhabitants. Undoubtedly the Antes were a tribe of that great Iranian invasion. Ariastan not only begot Ukrainians and all European nations, but it was the cradle of Persians and Hindus as well.

The art of writing was introduced into the Ukraine by Greek missionaries in the tenth century, but for long, even after their conversion to Christianity, it was unknown to ancient Ukrainians. The priests of the tenth century knew how to write with the pen, but Vikings used palm and fingers dipped in ink as their signature to state documents. This was called "piaterytzia."

That is why there are no written documents of this ancient people extant. Even at the time of the Viking Volodimir and the conversion of his men no written record was made of their needs. The oldest relic of Ukrainian literature is "The Ballad of Prince Ehor's Expedition"—literally, "the Word about Ehor's army." This dates from the twelfth century and was probably written by a survivor of that unhappy campaign. Another very old document is "The Chronicles of Nestor," the Monk of Kiev, but it was composed subsequently. From both of these productions we get evidences of the Ukrainian heathen religion or practices, but so slight are these references that they do not help us very much.

It is indeed odd to be able to say that the ignorance of the people saved for the scholars, in the oral literature of the folk, all the Ukrainian past.

Owing to the small attention given by the Greek Catholic and Uniat priests towards the education of the people in Christian doctrine, the ancient pagan soul is hidden under the thin veneer of Christianity. Folk-lorists and philologists visited villages to collect the customs and folk-songs, and in this way the ancient Ukrainian faith is resurrected in the intellectual treasure of the villagers.

From Nestor's Chronicles we can imagine life in the Ukraine as far back as the ninth century A. D. Nestor gives us a description of several Slavic (Antes) tribes which were dwelling between the Dnieper and the Baltic. He calls the Ukrainians "Poliane," that is, a people living amid fields. (The name "Ukraine" appears first in the Ukrainian Chronicles of the twelfth century.)

The main occupation of the Poliane was agriculture, but with it went bee-keeping and hunting. They lived in villages or strongholds—"horods"—along the banks of the Dnieper and its tributary streams.

The "Chronicle" says that in the time of the Viking Volodimir there was standing in Kiev an image of Perun, the thunder god. And from the "Ballad of Ihor's Expedition," from folk-legends, tales and songs we find that before the Ukrainians became Christians they had some gods and goddesses and an entire religious cult. That faith was in complete harmony with the phenomena of their nature.

The joyful shining sun—Sonetchko—the ancient Ukrainians imagined as a young and beautiful girl-goddess—Lada, goddess of love and life. Thunder was the noise made by the wheels of the Thunder-God who was the wooer of the Sun-Goddess. The name of the Thunder-God is accepted by Polish and Russian scholars as Perun. But it is possible that they are mistaken. Perun is the name of the Polish Thunder-God, as Perkun is of the Lithuanian one. At the present time some of the people of Poland call a thunder-bolt "Perun." But in the Ukraine, except in the Polonized southwestern Ukrainian provinces, the word "perun" is not used at all. Nestor alone left us that word, giving the name to the local god, that of Kiev.

The real Ukrainian Thunder-God was called Yoor[3]—and by this he is widely known in the Ukraine. There it is common to replace the Christian name of "George" by "Yoor." No philological relation between the two words can be traced.

That was simply a trick of the Greek-Orthodox priests. Not being powerful enough to expel the influence of the pagan god Yoor, the priest told his people that George was identical with it, the legends of one appertaining to the other. The Christian legend says that St. George saved a princess from the claws of a dragon, while the Ukrainian myth relates that the evil god of Frost, a dragon, stole the beautiful goddess Lada (from the word "ladna" beautiful) and hid her in his domain of eternal cold. Being without sun, men were left in the clutches of Marina, the goddess of winter. Then the god of thunder, Yoor, went to rescue his beloved; he killed Koschey and turned back to Ukraina, carrying Lada with him. The latter expelled Marina by her smile, and all became again warm and bright for mankind, in fellowship with his beneficent god.

From the cry of Yaroslavna in "Ihor's Expedition" we learn that the god of wind was "Strib-boh," and winds are called "The grandsons of Strib-boh" (Boh, god; derived from the Iranian divinity Baga; strib, from stribaty, to jump). The god of the heavens was Svareeh—Fire was Svarozhieh, the son of Svareeh. Wolos, wooly one, was the god of cattle. The flaming sun of summer had still another name, that of Hors. This word is only found in the "Ballad" above mentioned, and seems to have been borrowed by the Ukrainians from Egypt's god Horus. The Ukrainian Cupid was Lel, the son of Lada.

The people of those days imagined the world surrounding them to be filled by every kind of spirit and chort. (The latter is not exactly a devil, but is rather a little demon of the swamps or hidden places)—Lisowiks, spirits of the wood, wodianiks, of water; russalkas, the souls of drowned girls or children; opirs, vampires; vovkoolaks, men who can change themselves into a wolf's image; widmas and widmaks, witches and warlocks; nitchkas, the shadows of night; Wey, the king of ghosts and other "unclean powers"—all in fact that the fantasy of those dark ages could conjure up. But all these held no relation to the four great gods, Yoor and Lada—Koshchey[4] and Marina. Man's very life depended on their vagaries. The first wished all to be under the power of eternal spring, swayed by love, multiplying. Not so the dark forces who tried to freeze the world and kill all life on the globe.

With that intent Koshchey tried always to capture Lada and hide her far away from the earth; he tried to prevent her helping the growth of vegetation by means of her warmth and light. So they imagined the changes of the seasons. Yoor and Lada were living with them in spring and summer; in autumn Koshchey appeared with the Witch Marina; Koshchey by subtlety killed Yoor and carried off Lada to his ice-castle, leaving Marina in charge of the world. The rivers and lakes froze, leaves fell from the trees, the birds fled

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*From *Queen's Quarterly*. This article is an English revision by Florence Randal Livesay of notes by her fellow-countryman, Mr. Paul Crath. Mrs. Livesay is the author of "Songs of Ukrania," for which Mr. Crath wrote the preface.

[1] The word Scythian was a collective name of many tribes of Iranian immigrants, given the name of the leading tribes. In the fourth and third centuries before Christ the supremacy passed to the tribe of Sauromotes or Sarmates, all the tribes being called by that name. Before the beginning of the Christian era these nomads were spoken of as Allons. There can be no doubt that among these Iranians were ancestors of the Slav race and Ukrainians in particular. In the view of history the Ukrainians appeared in the fourth century A. D., known to the Greeks as Antes.† The Byzantian historian Jordan writes of Antes and Slavs who waged war with Vinitar, king of the Goths. He showed that these Antes had possessed the area from the Dnister river to the Sea of Azov. (See History of Ukraina by Prof. M. Hrushevsky, pp. 26-32.)

†Under the name Ruthenians the Antes became known in Gaul where a tribe of Antes with other invaders came in the era of "the great migration of nations." The name "Russ" appeared in the ninth and tenth centuries as the name of the Dukedom of Kiev (correct pronunciation Kiyeev) or as the name of an army of mercenaries under the Dukes of Kiev. In the twelfth century, A. D., the name Russichi is used for all Ukrainian tribes. But beside "Russ" must be set the name of "Ukraina" also. After the Tartar invasion in the thirteenth century A. D. the independent political life of the great kingdom of Russ was lost, and it became a part of the Great Dukedom of Lithuania, then a part of Poland, being dependent on the Polish crown more in name than in reality. In the fifteenth and sixteenth centuries the inhabitants of Ukraina were known to the world as Chercassians or Cossacks, although the Poles still called them Russ. At the present time only the Ukrainian tribes of the Carpathian region call themselves Russini. The name Russ was transferred to the north, to the Tzardom of Moscow—hence Russia. The modern Antes call themselves Ukrainians, and their land from the San River to the Caucasus they call by the poetical name of Ukraina.

[2] There were probably three great waves of Aryan migration; those whose deity was Deus (Celts); those who worshipped Got (Teutons), and those whose God was Boh (Slavs).

The ancient Ukrainians believed in life after death; and the dead might appear among men; hence it was needful to conduct funerals with all possible pomp to merit the good will of the dead and prevent his evil influence should he wish to exert it. In these burials all kinds of domestic utensils and slain animals were placed with the body; it often occurred that a man's widow slew herself on the grave-hill. An Arabian traveller describes a funeral in the Ukraine which he witnessed in 922: The dead man was clothed richly placed in a boat, with tent-canopy; beside him were his weapons and many kinds of food and drink. They asked if any of his slave maidens would die with him, to live with him and the souls of ancestors in a beautiful green orchard in Paradise. One of the maidens agreed to this, and she was slain on the day of the funeral and placed beside the man's corpse. They threw into the boat two horses, two cows, a dog, a rooster and a hen, cut in pieces. Then these all were burned and a grave-hill heaped over the spot.—Prof. Hrushevsky: The History of Ukraina.

[3] Many proper nouns and words are derived from Yoor: Yaroslav, the glory of Yar; Yaropolk, Yar's people; the Muscovite god of summer was Yarilo.

[4] The Muscovite Koshchey, fleshless; the Ukrainian name is lost or perhaps survives in Moroz, the Frost.

to Earey or Wirey (a legendary land of the South, probably Egypt), and the old woman, Winter, tried to destroy all mankind. Men, like motherless children, cowered in their huts.

But the wolf with silver hair—probably the god of the moon—picked up the mangled body of Yoor, put him together, sprinkled him with the water of healing (snow water) as in the Russian Skazkas, and then with the water of life (rain)—and the god of thunder arose.

Alive again. Yoor sat on the back of the wolf and went to the rescue of Lada. The return of spring was the proof that Yoor had brought Lada back again to the Ukraine. As children we all were told this tale. In the long winter evenings our grandmother narrated the story of Ivan the Prince and the beautiful Tzarivna. The dragon killed the prince, the wolf healed Ivan, the Tzarivna or Korolvna was saved—how clear is all this in our memory! This is now but a tale, but in reality it was a myth of the ancient Ukrainians, as we have tried to show. From generation to generation it was handed down, and now, though the names of the heroes are changed, the essential features remain.

The ancient Scandinavians had a faith somewhat akin; their beautiful tales anent their gods and goddesses much resemble those of Ukraine.

Except for the image of Perun, in Kiev, there is no evidence that the ancient Ukrainians worshipped idols. But they worshipped sacred trees. In an ancient Kolada or Christmas song we read: "In the forest under the oak tree seeds are planted; youths and maidens are seated on the seeds and they are singing a hymn—'Ko Ladi' (to Lada). Somewhere a fire is burning under the cattle, and the Old Man (priest) sharpens a knife to kill a goat." Here is pictured a pagan Ukranian offering.

The institution of the priesthood probably existed; but not in a highly developed form. A philological interest attaches to the Ukrainian word for priest—"Zhretz," which means "devourer." Probably sacrificial offerings were deeply rooted as a custom in ancient Ukraine. Even in these days the eagerness of the people to make every kind of food-offering to Christian priests is very noticeable.

So universally accepted was "black art" that Christian priests time after time sought to play the role of magician. They were called by the peasants to expel "chorts" from their huts; to sprinkle the fields in drought; to show the hem of the sacramental cape to a sick man; to extinguish fire by holding up icons or images of the saints.

The present conception of the Greek-Orthodox and Uniat Ukrainians as to the "Four Last Things" is not of Ukrainian origin. It is the Egyptian story of the Judgment of Osiris worked over and mingled with the Hebrew eschatology. The Ukrainian ancient faith had in itself the seeds of conception of good and evil, but not so markedly as in the Persian religion, where it was elaborated in the myth of the struggle between Ormuzd and Ariman.

Nitrogen's Part in Nature

By F. Rowlinson

At a time like the present, when all loyal citizens are doing their utmost to increase the food supply of the nation, we hear numerous and heated discussions amongst our allotment holders as to the comparative merits of this fertilizer or that. Listening casually to the talk of the layman, one who has some knowledge of chemistry is struck by the average man's ignorance of the reasons and process of plant feeding. So it may not be amiss to give a brief account of some of the chemical changes involved in the growth of plants.

All living matter, be it vegetable or animal, requires for its growth considerable quantities of the element nitrogen. Of this there is an inexhaustible stock in the atmosphere around us; the problem is—how to make it available? No animal can assimilate the nitrogen of the atmosphere, "free" nitrogen as it is called. Accordingly animals are totally dependent upon vegetable life for their supply of this essential element. We have now to inquire into the means by which the plant takes into itself the nitrogen which is necessary for its existence. Now most plants, like animals, cannot assimilate free nitrogen, but must be fed by it in the "combined" form. The sole exception to this rule is the class of plants known as "leguminosæ," the peas, beans and lentils. If these be examined there will be seen upon the rootlets small swellings here and there. These nodules contain bacteria such as the Azotobacter (which means the "nitrogen" bacterium), clostridium, and a few similar organisms. The whole group of these live in symbiosis with the plant, *i. e.*, partnership, and by their agency the "free" nitrogen of the air is "fixed" so that the plant can assimilate it. Thus it will be seen that peas, beans, etc., do not require a highly nitrogenous fertilizer, but are able to absorb their own nitrogen direct from the air.

The greater number of plants, however, do not act as hosts for the symbiotic bacteria, and must accordingly draw upon other sources for their nitrogenous food. The air consists principally of the two gases oxygen and nitrogen; and these two will combine together under the influence of the high temperature electric discharge. This condition is fulfilled each time there is a lightning flash through the atmosphere, and the resulting gaseous oxides of nitrogen are washed into the soil by the accompanying rain. There they form nitrates which are assimilable by the plants. This supply is by no means sufficient to maintain the fertility of cultivated soils, although it will suffice where large production is not sought. One method by which we make good the continual abstraction of nitrogenous matter from the soil is the very ancient one of digging in animal refuse and allowing it to rot. By this means, and the simultaneous action of certain other bacteria, the complex compounds in the animal matter are reduced to ammonia, and are then oxidized into nitrates. These bacteria are of great physiological importance in bringing the nitrogen into the proper condition, but, unlike the symbiotic bacteria, they do not in themselves add anything to the soil or plant. Unless the nitrogenous matter be supplied they are quite helpless.

The time-honored feeding of the plant by manuring is slow, wasteful and inefficient. It is but one step better than the old system, long since abandoned, by which each piece of land was allowed to lie fallow for one year in three, to recover the nitrogen drained out of it by cultivation. It has become imperative to supply a portion, at least, of the nitrogen by artificially prepared compounds containing it. These are of several classes: those containing nitrogen as ammonia, those as nitrate, and miscellaneous fertilizers such as "nitroline" or calcium cyanamide. The fertilizers containing ammonia are almost all derived from the coking plants and gas works, in which a portion of the nitrogen of the plants which formed the coal is recovered as sulphate of ammonia. The nitrate fertilizers are chiefly nitrate of soda, or Chile saltpetre. The former class requires the action of bacteria which are most prolific in light soils, to change them into nitrates before they are useful to the plant. The latter class are directly assimilated. Hence sulphate of ammonia is most useful on light loamy soils; nitrate of soda on heavy clay soils.

With the growing appetite of the world and the destruction of large quantities of nitrogen compounds as explosives, the problem of making two blades grow where only one grew before becomes more and more insistent. "England and all civilized nations stand in deadly peril of not having enough to eat. As months multiply, food resources dwindle. Land is a limited quantity, and the land that will grow wheat is absolutely dependent upon difficult and capricious natural phenomena." These words were part of a warning sounded by the great chemist Sir William Crookes as long ago as 1899. Today they are doubly true. It is imperative that the food supply of the world should keep pace with the increasing demand. There is one remedy for the evil—increased yield from the same plot of land. This means increased nutrition for the plants, and this in turn means more and yet more nitrogenous matter to feed them. There are three sources to which we can look. The first, the South American deposits of nitrate, is fast approaching exhaustion, and cannot last more than a few decades. The second service is the enormous deposits of coal, which contains some of the nitrogen of the plants the coal was formed from. As has been stated above, this can be recovered, at least in part, as ammonia when the coal is gasified. This supply will be chiefly developed where coal is cheap and plentiful, *i. e.*, in Great Britain, Germany and in the United States. But by far the greater proportion (80%) of our coal is burned in the state it leaves the mine, and all the valuable nitrogen is lost. This huge waste is incredible folly. Nero fiddled while Rome burned; we sit by in indifference whilst our potential food supply is allowed to roar away from our chimney stacks in thick clouds of filthy smoke.

The third, and most promising, source of nitrogen compounds is the atmosphere. By many chemical and electro-chemical processes, too numerous to describe here in detail, various forms of nitrogenous fertilizers can be obtained from the inexhaustible stock of nitrogen around us. Some processes are a glorified form of the combination of nitrogen and oxygen by the lightning flash, others depend upon the formation of metallic nitrides and their subsequent decomposition, and others again upon more complicated compounds still. Little progress has been made in England in this direction, but in Scandinavia, where water power is cheap and fuel dear, and in Germany, cut off from natural supplies, extensive undertakings have been laid down and have proved very prosperous.

Notwithstanding the great emphasis we have laid upon the importance of nitrogen's part in nature, it must by no means be supposed that nitrogen is the only essential for the growth of vegetable organisms. There are two more fundamental constituents, potash and phosphates. The former are supplied in wood ashes and by the weathering of felspathic rocks; the latter is obtainable in great quantities from the steel works, and less cheaply as bones and "superphosphates." But neither potash nor phosphates are volatile, and their use is not attended by the interest which envelopes nitrogen's part in nature with a romance of its own. Yesterday the molecule of nitrogen swept across the face of the earth in a roaring gale of wind. It was yoked with its companion oxygen by a lightning flash and passed into the soil in a downpour of rain. Today it will build up the marvellous cells of a grain of wheat; tomorrow it will nourish the tissues of a living, thinking body, afterwards to rise from decay into the air whence it came. And so it will pursue an eternal cycle from air to plant, from plant to animal, and from animal back to air or plant again, through the countless ages.

Transmission of the Trematode in Venezuela

The Trematode, *Schistosoma* (*Bilharzia*) *mansoni*, occurs frequently in man in Venezuela; adult specimens of this parasite were found by Dr. Risquez (1916) during post-mortem examinations in the School of Medicine at Caracas in 20 per cent of the cases. Drs. Iturbe and González have recently published, from the laboratory of the former, an account (8 pp., two plates) of experiments made with the view of finding the intermediate host of this parasite in the neighborhood of Caracas. The four common fresh-water "snails" of that area are two species of Planorbis, an Ampullaria, and a Physa, and the first three can be infected experimentally by adding to the water in which they are living the ciliated larvæ, or miracidia, of *S. mansoni*, but it is evident that *Planorbis guadelupensis* is the only species which naturally serves as the intermediate host of *S. mansoni*. The development of the miracidium in this Planorbis, and the formation of rediæ (described as having a widely open mouth and a rudimentary gut) and cercariæ, are in accord with the account by Miyairi and Suzuki of the corresponding stages of *S. japonicum*. The cercariæ of *S. mansoni*, after escaping from the infected Planorbis, can live in water for at least twenty-four hours. Experiments on white rats and on young rabbits and dogs showed that they acquire the parasite by the entry of cercariæ by the mouth or through the skin, though the actual penetration of the skin by the cercariæ was not observed. Naturally infected *Planorbis guadelupensis* were found in six of the seven localities examined near Caracas, and of 400 specimens from one of the canals 120 proved to be infected.—*Nature*.

Desiccation of Potatoes in Germany

The number of factories for drying potatoes in Germany increased from 3 in 1903 to 488 in 1914; in 1916 there were 841, of which 551 were in the provinces of Brandenburg, Pomerania, Posen, and Silesia. With the present number of factories working day and night for 200 days, 12 million tons of dried potatoes can be produced from 30 million tons of raw material, but this output does not meet the requirements for cattle as well as human beings. The technology of desiccation has made rapid strides. Roller apparatus (*Walzenapparate*) and drum driers (*Trommelapparate*) are now generally used. The former can deal with 1.2—1.5 tons of potatoes an hour and the latter with quantities up to 5 tons an hour. The product can be preserved almost indefinitely. It is made in the form of flakes and cubes for cattle, and various flours for human consumption. The machines are easy to run, those of medium size requiring 8-10 h.p. and the larger ones 15-25 h.p. On an average, 12-14 tons of coal is used per 100 tons of potatoes, for the flaked product, and 8-10 tons of coke for cubes. Machines for making cubes can be used also for drying beetroots, leaves, cereals, grass, and other vegetables.—Note from *Jour. Soc. Chem. Ind.* on an article by Parow, Georgine, Konigsburg.

After one season the cottonwood branches used for posts took root and began to grow

At the end of the second season the fence became a dense growth of cottonwood saplings

A Protective Ditch Fence

TROUBLED with floods caused by storm waters continually overflowing and breaking out the banks of an emergency drainage ditch, the city engineer of Redlands, Cal., solves the problem at small cost by his ingenuity.

He noted that the City Park superintendent was trimming the cottonwood trees of Redlands and conceived the idea of utilizing the tree wood to build a fence along both sides of the troublesome ditch. The cottonwood trunks were cut in convenient lengths for fence posts and set three feet deep along the ditch banks. Some discarded railroad ties were also used in the work. To these posts wire netting was tacked and brush thrown behind the fence to keep the water from cutting the banks.

During the first winter floods the protecting fence had to be watched to prevent the rushing stream inundating it, but by the second year the cottonwood posts had sprouted roots and started growing firmly rooted into trees, which precludes them ever being washed away in the future.

Our Useful Servants: Magnetism and Electricity

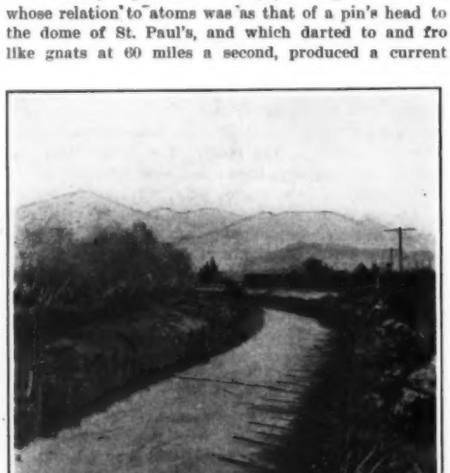
By Professor J. A. Fleming

IN his third Christmas lecture at the Royal Institution Professor J. A. Fleming gave a description of some of the varied achievements of "The Electric Current as a Heater and a Chemist," commencing with some information regarding the measurement of electric force, declaring that the measurements depended on the power of the current to decompose compound substances. Then he showed them how to decompose water into oxygen and hydrogen, and after they had seen the hydrogen flare, as it might, on a larger scale, in a Zeppelin, they settled down to the mysteries of amperes, volts and watts. Silver-nitrate, which had an interest as a factor in photography, was also taken to pieces, and a deposit of silver was seen to pass from one plate to another. Silver, said the lecturer, was the best of conductors, its resistance being only one-twenty-fifth of that of platinum. It was through the resistance of wires that they became red-hot, so that heat was obtained for purposes of cooking and for warming rooms. But only a few metals would stand the temperature created by high resistance to the current. Platinum was too expensive and iron became destroyed by the oxygen of the air. Fortunately, however, an alloy of nickel and chromium had been discovered, and this it was that gave utensils an efficiency, equal to about 95 per cent. of all the heat employed. The different response of high and low resisting metals to the current was shown in a wire constructed of alternate sections of iron and copper. Iron, offering six times as much resistance as copper, quickly became red-hot, and gave six times as much heat.

The hottest place on earth, said Professor Fleming, was the crater in the positive carbon of an arc light. By means of the lantern and screen the audience was enabled to see how the arc sprang from one carbon rod to the other, and to appreciate the bright violet light, due to carbon vapor, also the blue vapor from boiling iron in the crater. With these carbon rods enlarged to a foot square in the arc furnace, which in different forms was illustrated by pictures, it could be imagined that the temperature of the hottest place was indeed intense, and the value of the furnace in steel manufacture and for other uses could be realized. These furnaces and their purposes, one of which was the production of aluminum for framework of aeroplanes, were described, and the lecturer gave an account of storage batteries, stating that they were now used for driving submarines while under water, but the boats had to come up at intervals to recharge from dynamos driven by oil engines, and it was then "we got at them."

ELECTRICITY AS AN ILLUMINATOR AND DOCTOR

In his fourth lecture, on January 3, Professor Fleming dealt with "Electricity as an Illuminator and Doctor." Before electricity could be adopted as an illuminator, he explained, the properties of light must be understood, and, as light was transmitted in waves, it was necessary to comprehend these also. Above all, it was needful to know what electricity itself really was—a question to which, as the lecturer said, there was scarcely any answer twenty years ago. Electrons, whose relation to atoms was as that of a pin's head to the dome of St. Paul's, and which darted to and fro like gnats at 60 miles a second, produced a current



Protecting fence as first laid out

between the atoms, and, through bumping up against them, radiated light and heat; also, when they were stopped suddenly they propagated waves. This lesson was enforced by some pretty experiments. The hues of the prism as they revolved on the screen were seen to disappear until only a white disc remained, for white light was a combination of all the colors. The trouble was to get them all into the bulb. Red made a prompt appearance, but blue was shy, and demanded a higher temperature. Yet if the temperature was raised the wire fused unless it were of an expensive material like platinum, and therefore Edison made a carbon wire out of a strip of bamboo which he heated in an iron box. Other filaments were tried, and eventually success came with the use of tungsten, which was drawn to wire so fine that it could scarcely be seen.

Professor Fleming exhibited and explained various kinds of burners, showing how by automatic regulation the wastage of the positive carbon in the arc light was overcome, and evoking special interest by an account of searchlights. He described high-frequency currents which had virtue for medical purposes, and gave them illustration by the production of a miniature aurora-borealis in the form of a lovely ring of pink light. Finally, he dealt with the Roentgen rays, and, having shown how they were produced, demonstrated their uses in the treatment of wounds and for other purposes by the exhibition of a number of pictures, illustrating the transparency, not only of living creatures and their limbs, but of such solid objects as his own spectacle case, through which the spectacles could be seen. An unexpected faculty of the rays proved to be the detection of false diamonds, a real diamond being transparent to them, while the counterfeit was opaque, for it was not made of carbon but of silicate of lead.

ELECTRIC DYNAMOS, MOTORS, TRANSFORMERS AND RAILWAYS.

In his fifth lecture on Saturday last, Professor Fleming exhibited various dynamos on the screen which had been perfected with a steady current about thirty-five years ago, and explained how the difficulty of coupling the engine direct to the dynamo for the electric supply of ships had been overcome. It had been accidentally discovered that the dynamo was a perfect reversing machine, capable of converting the electric energy induced by steam back into mechanical power. Small electricians could now recognize that to all the intricate additions and modifications that had improved the dynamo was due the power of transmitting electric energy over long distances. Pictures of the great power station at Niagara, with its dykes and wells carrying the water from the upper river, transformers, and two-phase alternating machines were appreciated. Of three million horse-power running to waste at Niagara, 100,000 was now being transmitted for industrial and domestic use, so that electricians of the future could see that there was plenty for them to do. As we had no such sources of water-power, observed the lecturer, it behooved us to conserve our coal. Our system of many stations supplying different areas was wasteful, and we could economize by establishing super-power stations in a few areas. The American found it economical to use large machines, one of which, of 50,000 horse-power, was equal to ten of our stations put together. Professor Fleming also explained electric traction, and showed a picture of the electric shovel used in the excavations for the Panama Canal. This was so tractable that a child could work it, and altogether the audience carried away the gratifying impression that electricity was a very docile force when once the wire entanglements conducting alternating currents had been unravelled, and all the calculations for the measurement and application of energy had been worked out.—*English Mechanic.*

Flameless Photographic Lamp

THIS interesting little lamp works on the incandescent principle, and is specially useful for tourists. Any alcohol lamp, or a small bottle provided with a round wick, is used. The wick is spread out in a bunch just above the opening of the bottle, and when wet with the alcohol, place upon it the Barden "photo-incandescent cone," then light the wick, burn for five minutes, blow out, and the small piece of the substance will continue to absorb the alcohol and burn with a red glow without being consumed.

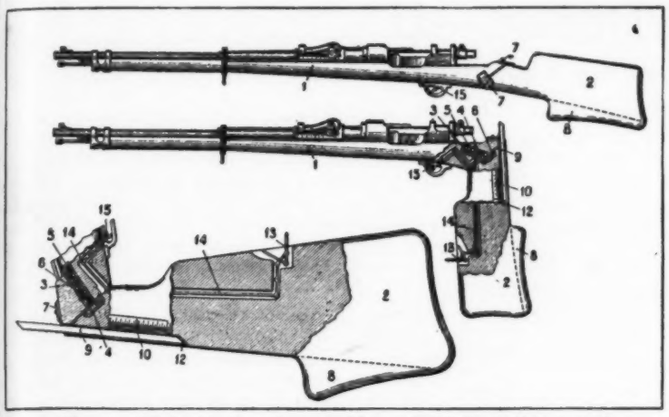


Fig. 1. Schulz rifle in ordinary position and with the butt depressed

1, stock; 2, butt; 3, socket; 4, pin; 5, spiral spring; 6, revolving button; 7, bolt; 8, second heel or shoulder; 9, moveable plate; 10, moveable pointer; 12, reflector; 13, depressible lever; 14, jointed rods; 15, trigger. The lower figures gives the details of the butt.

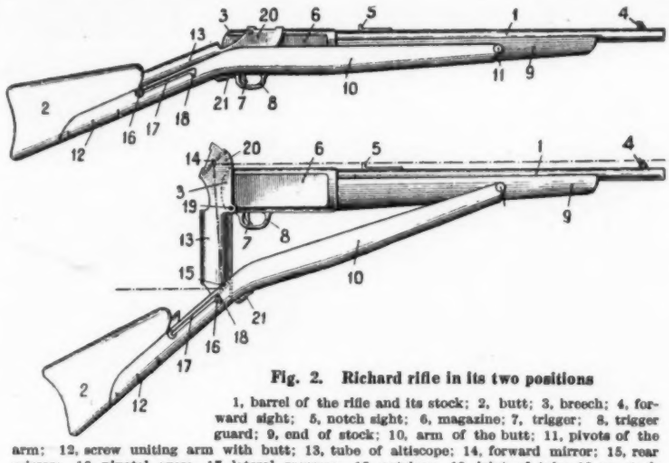


Fig. 2. Richard rifle in its two positions

1, barrel of the rifle and its stock; 2, butt; 3, breech; 4, forward sight; 5, notch sight; 6, magazine; 7, trigger; 8, trigger guard; 9, end of stock; 10, arm of the butt; 11, pivots of the arm; 12, screw uniting arm with butt; 13, tube of altiscope; 14, forward mirror; 15, rear mirror; 16, pivotal axes; 17, lateral grooves; 18, notches; 19, joint of tube 13 on stock in contact with barrel; 20, portion of altiscope fitting into rear end of barrel.

Periscopic or Altiscopic Rifles

AN interesting comparison of German, French and American inventions enabling an infantryman to fire accurately without exposing his head above a sheltering trench or rampart appeared recently in *La Science et la Vie* (Paris.) The first two consist of specially constructed rifles with lowering stocks, while the third consists of a carriage which can be applied to an ordinary rifle.

The German gun was invented by Wilhelm Schulz in 1911 and has a depressible butt, as shown in the accompanying illustration (Fig. 1). The stock and butt are cut apart in an oblique line, the two pieces of wood being ordinarily held in close contact by a pin surrounded with a powerful spiral spring, but capable of being pulled apart by a certain amount of effort, the spring bringing them back to their original position as soon as the effort is relaxed. The pin and the spring are connected to a revolving button attached to the butt of the gun at the point where it is separated from the stock in such a manner that when the two pieces are in the separated position, one of them, the butt, can be made to revolve around its axis through a distance of 180°, *i. e.*, a half-revolution, the top and bottom being thus reciprocally reversed. When the effort which has separated the two parts ceases to be exerted the two parts are rejoined, as remarked above, by the action of the spiral spring, but on account of the oblique line of separation the butt is then brought into a position almost perpendicular to that of the barrel of the gun. The two parts are then fixed rigidly in this position by means of bolts.

A second "heel" or "shoulder," serving as a support, is made on the other side of the butt, and the gunner is thus enabled to fire from the trench while still under cover, his head remaining considerably below the axial line of the barrel.

A sliding plate, forming a mirror, and inserted in the butt, in combination with a movable pointer and a reflector enables him to aim correctly, the movable mirror serving both as a second back-sight and as a second elevation scale when the butt is depressed. Finally, a depressible lever, governed by a spring and sunk in the butt, is connected by means of jointed rods with the true trigger in such manner that this can be operated from within the trench.

Another altiscopic rifle (Fig. 2), differing considerably in design from the one described above, has been patented by an American inventor. It has a jointed connection of the stock which permits the displacement of the barrel with respect to the butt, and an altiscope (or periscope) combined with these parts, which comes into the operating position at the moment of the relative movement of the barrel and the butt. An arm is mounted on a pivot between the barrel and the butt and extends between these parts to permit the separation of their extremities. The altiscope is ordinarily situated between the barrel and the butt, and is fastened by a pivot to the arm and to the part of the stock next to the barrel.

The preceding designs make necessary the use of a special rifle. M. Hervé has designed an apparatus which permits the use of any rifle at all. This is a firing carriage whose method of operation is shown in Fig. 3.

Improvements in Zeppelin Design

L49, the Zeppelin captured almost intact in France on October 20, does not differ very much in its general characteristics from *L33*, which was described in these columns last year, but there are quite a number of detailed improvements which are interesting to record.

The dimensions are approximately the same—196 metres (643 feet) long and 24 metres (78 feet) maximum diameter—but the shape has been improved to a better streamline form, there being little, if any, parallel portion in the later type.

The familiar method of construction remains, and it seems as if this had now become settled practice so far as rigid airship design in Germany is concerned where a metal is the material employed—and, indeed, in wooden ships of the Schütte-Lanz type (which are still being employed, whatever may have been said to the contrary) the salient principles are practically the same. In general, the design consists of a series of transverse frames or "rings," formed of built-up lat-

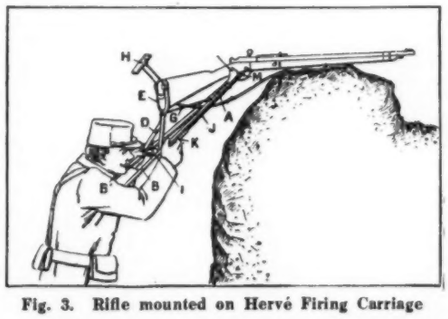


Fig. 3. Rifle mounted on Hervé Firing Carriage

A, frame of carriage; B, arm of frame; D, folding support; E, part receiving the butt of the gun; F, support of guard of the rifle on the carriage; G, brace; H, I, mirrors of periscope; J, rod; K, head of rod; M, hook connected with trigger of rifle.

tice girders, connected together by longitudinal girders, of which there are 25, of similar pattern.

It will be remembered that in *L33* a new feature was found in the fitting of a central wire cable running from end to end of the airship to assist in resisting the shear forces. This has been retained in *L49*, but the reinforcement of the transverse frames by king-post bracing, which occurred at every alternate frame in *L33* and was perhaps the most prominent innovation from the constructional point of view, has been reduced in importance in the new ship by being limited to five or six of the eighteen rings. In cross-section the airship is, like its predecessor, a regular polygon of 25 sides with a four-sided nose-piece and hexagonal tail. Along the inside of the airship runs an "A"-shaped keel, slightly larger than in *L33*, and about 12 feet in height, which serves the triple purpose of a structural keel (from which the hull receives most of its rigidity), a walking-way between the different cars, and a housing place for the petrol tanks, water ballast bags, bombs, etc.

Each gas bag, of which there are eighteen, is fitted with two valves: one, which is hand-operated by means of a cable running along the keel to the control cabin, is situated at the top, while the other is fitted near the bottom of the bag and is automatic. The latter valves are arranged in pairs, that is to say, two adjacent gas bags have their valves opening on the same side, so that the escaping gas may be taken away into the open air through funnels formed of light aluminum hoops covered with fabric, leading to the top surface. The same ventilating shafts serve to remove any fumes arising from leaks in the petrol tanks.

The bombs are slung on the inside of each leg of the "A" of the keel, and are electrically released from the control cabin, a shutter in the outer cover being opened by the same process to allow the bomb to fall through. In somewhat similar fashion the petrol tanks, which are fitted in guides for the purpose, can be released and jettisoned if it is desired to lighten the airship. This accounts for the finding of isolated petrol tanks in different parts of the country after a Zeppelin raid, and a discovery of this sort does not, therefore, by any means imply that the Zeppelin has been hit by gunfire as is sometimes thought. The gas bags are, when looking along the airship longitudinally, saddle-bag in shape, so that their lower portions sit, so to speak, astride the keel, and it is in this lower portion alongside the keel that the automatic valves mentioned above are situated.

The forward car is much the same as that of *L33*, though it is of somewhat improved design. It consists essentially of two portions separated by a few inches from one another. The back portion is the engine-room, in which is a 240 h. p. Maybach engine, while the front forms the wireless cabin, and, in front of that, the control cabin of the commanding officer. In this cabin are located the engine-room telegraph, steering and elevating wheels, valve controls, bomb-release gear, etc., and it is provided with an overhang in front fitted with a glass ledge and glass windows, so that the commander has a view straight down as well as ahead and on each side.

The two wing cars (or "power eggs"), each fitted with a 240 h. p. Maybach engine, are considerably altered from those of *L33*, being true streamline in shape and considerably smaller, besides being of lighter construction. The accommodation is very cramped and they must be very uncomfortable on long flights.

The greatest innovation is perhaps in the engine and propeller arrangements of the stern car. In *L33* this car was fitted with three engines, one driving a propeller direct and the other two driving wing propellers on brackets on the side of the hull. In *L49* the whole of the wing propeller system has been abandoned (which must have enormously decreased the resistance) and only two 240 h. p. Maybach engines are fitted, these being geared together to drive a large propeller in the rear of the car.

As the newer ship is said to be at least as fast as the older type it will thus be seen, as there are only five engines instead of the original six, that an amount of resistance has been got rid of equivalent to the thrust of one 240 h. p. engine, by improving the general shape of the hull, streamlining the wing cars, and discarding the wing propellers with the attendant tangle of bracing struts and wires.

Each engine is provided with a radiator fitted on top of the car in guides, so that it can be raised or lowered in order that the amount of cooling area exposed to the wind can be varied at will. This has manifest advantages in view of the great heights now attained by these airships.

As far as armament is concerned, there is a gun platform to take one or two machine guns on the top surface near the front, but the gun platform which was fitted in the tail of *L33* has been discarded. There are two mountings for machine guns in each of the front and rear cars, while the wing cars have one mounting each on the outside.—From *Aeronautics*.

The Causes of Diseases—II*

An Attempt at Classification with a View to Prevention

By Ernest S. Reynolds, M.D. Lond., F.R.C.P.

Concluded from Scientific American Supplement, No. 2198, Page 107, February 16, 1918

AGE

We must now consider abnormal changes due to age. It is permissible here to include congenital affections (apart from those due to injury), many being due to abnormal or arrested development. Later changes may be either general or local. General changes seem to fall more especially on the circulation, leading to diseases of the heart and blood-vessels, with subsequent affections of the brain and spinal cord, with simple-mindedness, loss of memory, definite mental disease, brain and cord softenings, and hemorrhages. (I would like to draw attention to this point to senile paraplegia from deficiency of circulation in the lumbo-sacral cord described by Sir William Gowers, and not, I think, sufficiently recognized.) Together with these vascular changes must be included the granular kidney, with its multitudinous range of symptoms and signs.

Local changes may affect many organs. Those of the hair and skin are obvious. In the nervous system I would include the following diseases: Paralysis agitans, senile tremor, adult chorea, anyotrophic lateral sclerosis, progressive muscular atrophy and chronic anterior poliomyelitis; amongst mental affections certain of the incurable adolescent insanities which rapidly pass into incurable dementia and various senile insanities. Early degenerations of ductless glands are manifested by myxœdema, and perhaps by some types of Addison's disease; early senile changes in the sexual organs by an abnormal menopause, early loss of sexual power in men, and by early changes in the prostate gland. Early changes in the eye may cause too early errors of refraction or affections of the lens, while changes in the ear may set up deafness or labyrinthine vertigo or tinnitus.

The important point about all these affections is that they are absolutely incurable.

NEOPLASMS

We must now consider the question of neoplasms, and I will take Dr. Powell White's definition that a neoplasm is an abnormal mass of cells, tissues or organs resembling those normally present but arranged atypically; it grows at the expense of the organism without subserving any useful function. Teratomata due to faults of development will almost certainly occur in some of the descendants of our original islanders, and also, one must suppose, as no two of our community are alike, that simple tumors will occur, such as warts, moles, fatty tumors, outgrowths of bone or cartilage. But what shall we say of malignant tumors? Such are not always hereditary, and no one has yet proved that they are in any way caused by germs. So far as I have been able to observe, the commonest antecedent of large numbers of malignant growths is injury, including, of course, irritation. If we say for the sake of argument that it is a cause then we must, I think, certainly admit that malignant growths will occur in our island. But there is obviously something else: everyone suffers, if not injury, then certainly irritation, even if it is only the daily passage of fæces. But not everyone suffers from malignant growth; the unexplained factor is either another cause, or much more likely some condition. So important does this seem that I would urge that research workers on the etiology of new growths would do well to turn aside from the search for the active cause and seek out the condition which allows the active cause to produce its effect. If this necessary condition, whatever it is, cannot occur on our island we shall have no malignant growth and the contrary.

PARASITIC DISEASES

I think we must assume that our island will not be free from parasitic diseases. It may be conceded that it is an island in a temperate zone, so that we have not to consider those greatest advances of modern medicine conducted often under enormous difficulties, discomfort and danger by our brethren in tropical countries. I am not sure that we can exclude flies, fleas, bugs and lice from the fauna of the island, however glad we should be to do so, and they may act, not only as direct irritants, but as disease carriers. Other animal parasites such as the itch insect and the various intestinal worms we may reasonably exclude.

*Bradshaw lecture delivered before the Royal College of Physicians of London, and republished from *The Lancet*.

DISEASES DUE TO MICRO-ORGANISMS

We almost certainly cannot exclude germs, for even in non-pathogenic states they are apparently necessary for the continued existence and for the decay of plants and animals. No one knows how the first germ started, but the more one wonders how the first germ became pathogenic the more fascinating does the subject become. I greatly regret that my ignorance of modern bacteriology will not allow me to discuss the matter as I should like, but I venture to refer to the interesting address on "The Nature and Degree of Specific Differences Amongst Bacteria" given by Dr. Andrewes to the Pathological Section of the Royal Society of Medicine on October 21, 1913.[1] There he points out that generic differences amongst germs are probably of great antiquity, and that certain small genera, such as *Bacillus anthracis*, *Bacillus mallei*, *Micrococcus melitensis*, are very fixed, but that other large genera, such as the streptococci, the diphtheroids and the coli-typhoid group are very variable and show a readiness to gain or lose their physiological characters under the direct influence of their environment and that in many cases by artificial means a non-pathogenic germ may become pathogenic and vice versa. This subject was also fully dealt with by Professor Adami in his recent Croonian lectures in which striking examples were given.[2]

It is highly probable that we all keep on the premises, so to say, what I will call domestic germs, which, as a rule, remain tame, but granted certain conditions of the host, such as starvation, fatigue or exposure to cold they become wild and cause disease. Such, for instance, are probably the *Micrococcus catarrhalis*, the pneumococcus, the staphylococcus, the *Bacillus coli* and the germ of rheumatic fever.

Other germs, such as the tetanus bacillus, the *Bacillus aerogenes capsulatus*, and many of the bacteria of putrefaction, perhaps normally present in the soil, only become pathogenic if they are put into suitable surroundings. I am told that there is a possible family connection between a bacillus growing in Timothy grass, through the bovine to the human tubercle bacillus. Other bacteria and protozoa may live in perfect harmony with their hosts (such as *Bacillus pestis* in the rat-flea and certain protozoa in insects and birds) but are highly pathogenic in man.

Other micro-organisms living in the human body belong to groups which seem to have their members closely allied, but in which some are non-pathogenic, others highly pathogenic, and in which quite possibly the latter may have arisen from the former. Such, for instance, are certain organisms of the throat and nose closely resembling Weichselbaum's bacillus; and, again, the enteric group, varying from *Bacillus fecalis alkaligenes* to Gaertner's bacillus, the paratyphoid and the typhoid bacillus.

So that although we may not allow that certain very fixed types such as the germs of syphilis, measles, scarlatina or smallpox would affect our islanders without introduction from overseas it is reasonable to suppose that many diseased conditions due to germs may arise within.

HEREDITY

The last class of possible causes of disease is heredity. Our 2,000 persons we have supposed to be free from inherited taint. Is it possible for any of the first generation of their offspring to inherit disease conditions or tendencies owing to the habits or environment of the parents? This question has been so fully dealt with in Professor Adami's recent Croonian lectures and decided in the affirmative that it is almost unnecessary for me to touch upon it except to say that I thoroughly believe such inheritance may occur. And whether it is due to an action on the somatic plasm or the germ plasm is a matter of more or less indifference to the physician or to the hygienist, and I certainly do not propose to deal with what the late Sir Jonathan Hutchinson calls the logomachy of Weismannism. I think it quite likely that alcohol and lead poisoning in the parent may affect the offspring. Nor does it seem unreasonable to suppose that the effects of under-feeding or over-feeding may have their results in the children; or that such infective conditions as we have allowed may develop in our island should produce an hereditary lessened or increased immunity. And if we consider a few more generations we can easily see how many metabolic and nervous diseased states may result. But I shall consider hereditary disease again in a few moments.

[1] *The Lancet*, 1913, ii., 1239.

[2] *The Lancet*, 1917, i., 921, 961; 1917, ii., 20.

SUMMARY OF CAUSES

I have now shown how in our community of originally healthy parents and their progeny for, say, two or three generations disease may occur, and deaths at varying ages may result without any contamination from the outside world, and I have classified the causes of these results into:

1. Injury.
2. Food and feeding.
3. Poisons.
4. Occupation.
5. Stress.
6. Abnormal metabolism.
7. Abnormal age changes.
8. Neoplasms.
9. Parasites.
10. Heredity.

It goes without saying that the percentage of deaths from natural changes due to age will be much higher than in England to-day.

EFFECTS OF IMMIGRATION

If we now allow unrestricted immigration into the island we shall not introduce any new cause of disease but we shall much intensify at least three of our causes—namely, stress from increased competition, parasites and heredity. Those parasitic affections will especially act as causative agents which are of fixed types, such as syphilis, tubercle, the exanthemata, and so on, and we shall presently see what an enormous factor the parasite is in the production of disease.

HEREDITARY DISEASES

The subject of hereditary diseases must be considered in more detail. They can be roughly classified into eight groups: 1. Direct infection, of which syphilis is the one example, though some, such as Hutchinson, are prepared to believe that tubercle may be actually conveyed into the ovum. 2. The possible results of extrinsic poisoning in the parents by such agents as alcohol or lead. 3. Structural changes. These may be the obvious external changes, such as supernumerary or webbed fingers and toes, coloboma, or albinism. Or they may be internal structural defects, such as found in hemophilia, and perhaps myolonia congenita and anyotonia congenita should also be included; or latent structural defects which show themselves later as various skin deases—psoriasis, lichen xeroderma, urticaria or chilblains. For those who believe in the heredity of cancer, and I think most clinicians do, the unknown latent conditions underlying the affection may be perhaps included in this group. 4. Altered metabolism, as for instances, gout with its numerous manifestations, of which some only may be handed down, diabetes and obesity. 5. Idiosyncrasies to certain foods or odors. 6. Tendency to germ infection, possibly from some hereditary lessened immunity. The great example of this group is of course tuberculosis. But I wish to take this opportunity to emphasize the enormous influence of heredity on acute rheumatic fever, an influence which I do not think is sufficiently pointed out. To my mind it is of equal importance as regards ultimate human suffering to tuberculosis. The more one inquires into the family history of rheumatic patients the more one is impressed with the number of families in which the parents, especially perhaps the mother and the brothers and sisters have been affected with rheumatic fever, valvular disease of the heart, with chorea, or with various very definite rheumatic skin affections, such as erythema nodosum, with purpura or with that variety called Henoch's purpura which personally I believe to be merely a manifestation of rheumatism. 7. Nervous irritability or instability. In this group we have, *par excellence*, epilepsy, habit spasm, stammering, migraine (on the sensory side), asthma, the alcoholic habit, the various types of neurasthenia and certain insanities, many being of the curable type. 8. Tendency to abnormal age changes, in which I include certain insanities of the progressive incurable type, such as incurable adolescent insanities and early senile insanities; adult

chorea; Friedreich's ataxia and various types of myopathic paralysis, including family peroneal atrophy; and finally, and most important, the changes produced by hereditary increased blood pressure with early arteriosclerosis.

Now it will be at once rightly argued that to call a disease hereditary does not explain its cause. The heredity is generally only a condition, and some of the other nine classes of causes have to be brought in as factors before an effect is produced. But the importance of heredity in determining the future of a race is so great that it is quite legitimate, I think, to give it a place in my list.

CONSIDERATION OF ENGLISH MORTALITY TABLES FOR 1913

We can now suppose that by unrestricted immigration and in the course of many generations the health and disease of our island has reached the condition in which England is to-day. In dealing with this we have unfortunately only very imperfect statistics of morbidity. We can obtain roughly the number of insane and the types of insanity, a class more cared for by the State than any other; or the numbers and character of certain notifiable infectious diseases, but that is all. For other information we must turn to the mortality tables of the Registrar General. These are notoriously imperfect, depending, as they do, on certificates of death, which are, I am afraid, sometimes so worded as to give as little information as possible. To show how little they indicate real disease incidence, only 1,800 deaths are attributed to acute rheumatic fever, which with its sequelæ is one of the most potent causes of disease; only 1,200 to rheumatoid arthritis, another common affection; only 2,000 to syphilis; whereas 26,000 are classed as syncope, merely the final cause of death of many different diseases.

But in spite of these defects the mortality tables deal with such large numbers that some hint, at any rate, is afforded of the morbid state of the community, and they are therefore worth examination. I shall take the year 1913 (so as to exclude war conditions) and shall only give approximate figures. There was a total of 500,000 deaths.

Of these 134,000 (over one-fourth) were due to infectious diseases directly, and to these should really be added an enormous number of deaths ascribed to heart, lung, kidney and nervous diseases, the primary cause of which was germ infection. Of these 134,000, 50,000 (one-tenth of the whole death rate) were due to tuberculosis in some form, 37,000 to pneumonia, 10,000 to measles, 9,000 to epidemic diarrhoea, 6,000 to influenza, and 5,000 to whooping cough; 46,000 were attributed to respiratory diseases (excluding pneumonia), of which 39,000 were due to bronchitis, but this is very frequently merely a terminal phenomenon; 39,000 (nearly one-twelfth of the whole) were due to cancer or other forms of malignant disease, 38,000 to disease of the blood vessels, 30,000 to diseases of the digestive system, 27,000 to nervous diseases, 27,000 to heart disease, 26,000 to syncope (which is again a terminal phenomenon, but may include many valvular affections of the heart), 20,000 violent deaths, 15,000 to Bright's disease, and 12,000 to atrophy and debility (a classification of no value). There were 18,000 premature births. Old age is accredited with 30,000 deaths, or one-seventeenth of the whole.

As I have said, these figures give us some hint of disease conditions, but certainly nothing more than a hint of prime causes. For instance, three most potent prime causes have very low figures—venereal diseases, 2,000; alcoholism, 1,900; and rheumatic fever, 1,770. I can understand a certain diffidence in entering syphilis or alcohol as a prime cause on a death certificate, but there seems to me to be no excuse for not naming acute rheumatism, except, perhaps, that it is even not yet sufficiently recognized how slight, especially in children, its manifestations may be, nor that chorea in children is for all practical purposes a sign of rheumatic fever, and, finally, that the enormous preponderance of cases of organic diseases of the heart valves is due to previous acute rheumatism.

It is interesting to compare my list of causes of disease with these figures, however imperfect and unsatisfactory, of the causes of death, to imagine how many of the 38,000 deaths from disease of blood vessels were due to abnormal old age or to stress and how many to syphilis, what proportion of the 30,000 ascribed to the digestive system was due to food and feeding, and what proportion of nervous diseases was to be attributed to germs, to stress, to abnormal old age, or to heredity.

DISSEMINATED SCLEROSIS

A disease in which I have been interested for years is disseminated sclerosis. It is in my own personal experience almost the commonest of organic diseases of the nervous system in which morbid changes can be found. It is a most distressing malady, not only to the patient, but also to the physician, for it comes on without any known cause, principally affects those in the full bloom of life, is no respecter of persons and has a most crippling effect for years before it causes death. In my own experience it is much more common in women.

Very frequently, indeed, much more so than is generally supposed, it first affects the optic nerve rather rapidly; this affection is generally temporary and may be followed by a long intermission, often lasting years. With or without this initial symptom sensory symptoms, often very indefinite, occur, and rarely there may be severe pains not unlike those of a definite neuritis. At the same time or later there are disorders of motion, which may be slight, like an indefinite ataxia, or much more marked from affection of the pyramidal tracts or of ascending nerve tracts; very rarely actual wasting of muscle may result. A very marked feature of the disease is the occurrence of intermissions and remissions, the longest intermission, as a rule, being between any early eye symptoms and the sensory and motor phenomena; so long, indeed, is this interval that unless closely questioned patients never mention the original eye symptoms and certainly never connect them with the this way a multiple gliosis results. I do not think some

CAUSATION

Pathologically the lesions are very widespread and their locality points to something distributed by the lymph in the vessels or cerebrospinal channels, or by blood in the blood vessels, and probably more immediately by the former. The cause, whatever it is, has a predilection for the medullary sheath and the neuroglia, which are the parts primarily affected, and apparently the chronic inflammatory changes are secondary. The astonishing thing is the very sharp limit to each diseased spot, one indeed so marked that Strümpell supposed, but not on sufficient grounds, that the disease is largely of an endogenous nature due to a congenital abnormality of those parts affected, and that in this way a multiple gliosis results. I do not think some interesting observations made by my colleague, Dr. Williamson, in his work on "Diseases of the Spinal Cord," have been sufficiently noticed. He says:

"The shape of the patches and their regular margins in disseminated sclerosis are suggestive of the infiltration of the nerve structures with a fluid of destructive character, the margins of the patch being determined by *physical conditions*. If a spinal cord which has been hardened in Muller's fluid be touched on its external surface or on the cut surface of a transverse section, with a minute drop of deeply colored fluid such as a strong solution of aniline blue-black, the fluid diffuses itself into the cord substance, and a stained patch is formed with a fairly regular, curved, clean-cut margin, a margin which passes through the various structures of the cord abruptly and indifferently, and thus resembles that of a patch of disseminated sclerosis. This fact is suggestive of the patches being caused by the infiltration of the nervous system with a toxic fluid, their shape and margin being determined by physical conditions."

In a footnote he adds:

"Alcohol and several other chemical fluids have the power of dissolving out the white substance of Schwann from the nerve fibres of specimens of the cord and brain kept in these fluids for long periods, whilst the axis-cylinders and other structures are left. Thus a microscopic appearance is produced on section which somewhat resembles that of one form of the sclerosed patches. This fact is of interest though the disease has no relation to alcoholism."

I think Dr. Williamson's observations certainly suggest that the toxic agent may be in the cerebrospinal fluid.

If we use our tables of causation of disease we can rule out injury, food, occupation, stress, age, neoplasms and heredity; also all extrinsic poisons. But we cannot set aside intrinsic poisons, nor altered metabolisms, nor parasites growing either in the nerve tissues or forming toxins which act on the nerve tissues. It was a long time before it was proved that acute anterior poliomyelitis was due to a germ, and we do not know at the present time whether the long-drawn out and peculiarly intermittent symptoms of myasthenia gravis are due to germs, altered metabolisms or intrinsic poisons, the only definite effects found being lymphorrhages in the muscles and some fatty degeneration of an enlarged thymus gland, and although of recent years the *Treponema pallidum* has been found in the brain of general paralytics it seems more probable that the essential changes of this affection and of tabes are due to the toxin rather than to the local growth of the parasite.

CONSIDERATION OF POSSIBLE CAUSES: NEED OF RESEARCH

On the whole, by subsumption of the case in hand under a general law and by assimilation of the case in hand to a known case of causation, it seems certain that disseminated sclerosis is caused by a poison acting on certain special nerve tissues. If this is an intrinsic poison, which I am quite prepared to believe, it is probably either a perverted internal secretion or a poison derived from the alimentary canal, possibly as the result of constipation. In this connection it is most important to keep in mind the postero-lateral changes found in the spinal cord in diabetes, pernicious anemia, and many exhausting diseases. If from a germ, is it from the germ of some known fever, such as measles, typhoid fever or influenza? I think from the previous histories this can be at once answered in the negative. Or may it occur as a late result of *any* previous germ infection independently of nature? I think this should also be answered in the negative, not so much because some of the patients say they have never had any previous germ infection (in which they may be mistaken), but more because it seems to me that from analogy it is highly improbable that a disease which in spite of its many varieties has so very distinctive a character both clinically and pathologically can be caused by any odd germ or germs which may have previously affected the patient. It may be finally noted that the disease resembles in many respects those nervous affections caused by syphilis, although we know that syphilis is not its cause, nor do the pathological changes resemble those produced by syphilis. But in its early affection of the eyes its widespread distribution of lesions, its intermissions and remissions and its long-drawn out duration the similarity is striking.

If due to a germ I am convinced it is a specific germ as yet quite unknown. Whether the intermissions and remissions are due to the continual presence of the germ in the body with varied powers of immunity from time to time, or whether to fresh infection is not known. If due to an intrinsic poison the remissions would of course be due to the manufacture and absorption of fresh masses of poison.

I am sorry to have to confess that in spite of minute inquiries into the previous histories of large numbers of cases of this disease I have so far entirely failed to elicit any evidence of any common factor, although my questions have covered a large field. There is evidently another field to explore, and I would strongly recommend to young members of our profession that here is a subject of research well worthy of attention and in which the discoverer of the true cause will gain a rich reward.

OTHER DISEASES

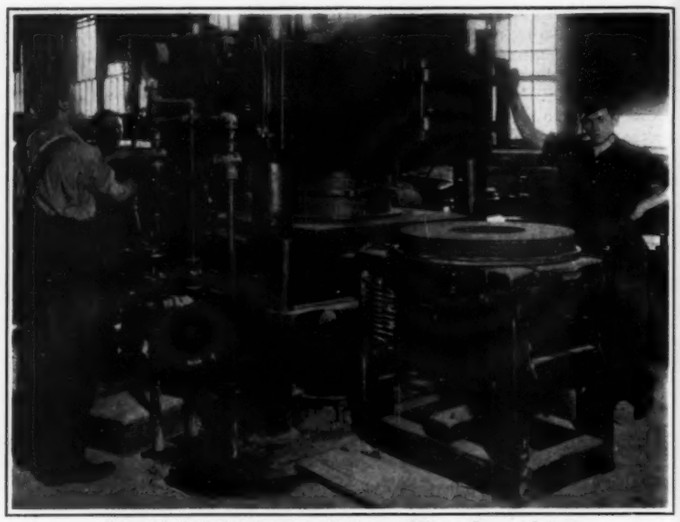
Another common and very distressing affection which needs urgent investigation as to its real cause is rheumatoid arthritis, for although I am willing for the present to admit that it is due to some toxin, this is by no means proved. Nor is it known if it is due to a germ toxin or to some intrinsic poison arising from imperfect metabolism.

Epilepsy and migraine, two very common and disabling affections, I have classed in the hereditary group; but how glad we should be to know the real cause.

Two other diseases, fortunately not common, I find a difficulty in classing—namely, spleno-medullary leukæmia and true facial neuralgia. The former seems allied to lymphatic leukæmia, which in many respects, especially in its frequently rapidly fatal results, resembles a germ infection, but in symptoms and course spleno-medullary and lymphatic leukæmia are so different that one sometimes wonders why they have generally been described together, unless it is that both are due to the same cause, but one running a very acute course, the other a chronic one, just as may happen in some other germ diseases, as, for instance, tuberculosis or glanders.

I have narrowed down diseases from the point of view of cause into ten groups only. This may appear surprisingly small and surprisingly simple. Allowing for that latitude which is always necessary when looking at very many objects from a large standpoint, I do not think I have taken many liberties in putting any particular disease into any particular group, although I do not pretend that the classification is one strictly conforming to the logical laws of classification. But I think the grouping is a convenient one, and I trust that on testing it will be found to stand criticism and may be helpful in enabling us to steer a true course to reach the haven of real cause and after reaching it to perform our next and highest duty, real prevention.

Puddled wheels are made by pouring the "slush" into tin forms in which they are partly dried



Some kind of wheels are made by moulding a damp mixture under a powerful hydraulic press

Modern Abrasive Wheels

Tools Now Indispensable in Fine Machine Work

By Raymond Francis Yates

GRINDING wheels are produced by the seemingly simple process of mixing abrasive grains of the desired grit together with a suitable bond, and baking the resultant mixture in a kiln after it has been formed or pressed into the shape of a wheel. This very elementary explanation, however, conveys nothing more than a general idea of the process used as it has reached such an advanced degree of development that it would be utterly impossible to cover the details of the work in anything less than a volume. The following treatise on the manufacture of abrasive wheels, although necessarily limited in length, covers the essentials of this great work, and it should prove to be of interest to the layman as well as of practical value to the engineer and mechanic.

With the advent of the electrothermic abrasive products, Carborundum and Aloxite, grinding wheels have become a prime factor in the industrial life of the world, and their constantly increasing importance and the widely divergent uses to which they are put has forced the manufacturers to produce wheels of various shapes, sizes, grits and bonds. By a carefully regulated process, which has been developed into nothing more or less than an exact science, the physical characteristics of the finished wheel are perfectly controlled.

Abrasive wheels are designated by the nature of their bonding substance, such as vitrified, silicate, shellac and rubber. Owing to the different chemical and physical nature of the bonding materials, the wheels of each class are produced by individual processes.

Vitrified wheels are bonded by substances that undergo vitrifaction when heated to the critical temperature in the confined atmosphere of a properly designed kiln. As vitrified wheels are more adaptable to the requirements of general grinding than other wheels, they are the most widely used, and the first of the following disclosures on the manufacture of abrasive wheels will deal with the process used in producing wheels of this particular class.

When Carborundum or Aloxite is removed from the electric furnace it is in large crystaline aggregations, which have been fused together by the tremendous calorific influence necessary for the production of these substances. The crystals are reduced to granular form by means of heavy roll crushers. The crushing process produces grains of various sizes, and after they are washed and dried, they are carefully graded by passing them over screens of various meshes. The frame that holds the screens is inclined about ten degrees and is made to oscillate by means of an eccentric arrangement which causes the grains to move slowly down the incline until they reach a screen which will permit them to pass through. The fine screens are at the top of the incline and the coarser ones at the bottom.

In the production of vitrified wheels the grain is first mixed with water and a fusible clay to form a mass of the proper consistency. The clays used are of various chemical formulæ chosen with great care by ceramic experts and mined in different localities. The mixing process is accomplished by means of barrel tumblers or paddle mixers, and, although mechanically simple, this process is of utmost importance, as it is very essential that the bond be thoroughly blended with the grains to produce as near a perfect homogeneous mixture as possible. Otherwise the wheels produced will not have uniform wearing qualities. The proportion of the various ingredients of the "mix," *i. e.*, grains, clay and water, is dependent upon two factors: the size or grit of the grains used, and the hardness of the bond in the finished wheel. The proportion of clay in a wheel of coarse grit will be different from

Barrel tumblers in which the grit, banding material and water are thoroughly mixed

that contained in a wheel of the same bond with a fine grit.

Vitrified wheels are formed by two distinct methods: they are either puddled or pressed. When a wheel is made by the puddling process, the mix or slush is taken from the mixers and "poured" into forms or moulds which are the approximate diameter of the finished wheel. When speaking of the wheels being "poured" into the moulds, the word poured is used in a very limited sense, as great care must be taken during this operation to exclude air bubbles. The mix is poured into the mould with a small dipper in the hands of a skilled workman. The dipper is manipulated in a particular fashion which eliminates all air bubbles. The form is then permitted to stand a considerable period to allow part of the water to evaporate. The dehydration is completed in a "drying room" where the proper temperature prevails which drives off the water from the interior of the mass by increasing its vapor pressure. The escape of the vaporous water from the interior tends to increase the porosity of the finished wheel. This feature of the puddled wheel makes it more adaptable to certain work than wheels formed by other processes. When the dehydration of the wheel is completed, it is placed in a modified lathe and turned to the proper diameter. After this, the wheel is incased in a saggar and placed in a vitrifying kiln, which, after being hermetically sealed, is brought to a temperature sufficiently high to fuse the clay contained in the wheel. The clay is changed to a solid, vitreous mass, which forms the skeleton of the wheel and in which the abrasive matter is imbedded.

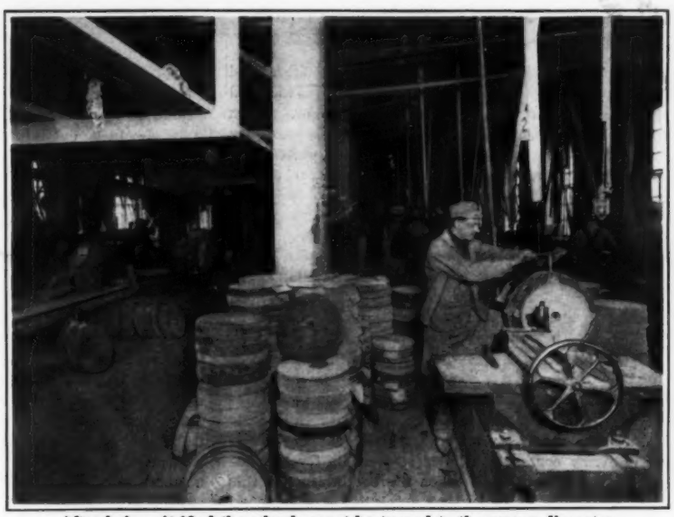
Pressed wheels are formed by hydraulic pressure and differ from the puddled product in that they are less porous. The aqueous content of the mix is much less, as it is only slightly more than damp. After the mix is put in the form, it is placed under the plunger of the hydraulic press and a definite pressure is applied, which depends upon the bond and grit of the wheel. It is very essential that a specific amount of mix be used for each wheel of the same grit, grade and bond, as a greater or less amount will cause a variation in the physical nature of the wheel, assuming that a definite pressure is applied. The remaining part of the process in the production of pressed wheels is the same as that followed in the making of puddled wheels, *i. e.*, dehydration and vitrifaction. There are certain difficulties in the manufacture of pressed wheels that makes it impractical to produce wheels above a diameter of 30 inches.

Sodium silicate (Na_2SiO_3) has been found to form a very suitable bond for abrasive wheels and, in many operations, silicate wheels possess an advantage over wheels utilizing other bonding substances. In forming the bond of a wheel, sodium silicate, unlike the clays used in vitrified wheels, does not undergo any physical change. In its common commercial form it has a high aqueous content and is very viscid and tacky. After it is mixed with the grains it is tamped into a form by a workman especially qualified to accomplish the operation, which is a very difficult one and requires considerable experience. After the wheel is so formed it is dried and placed in an oven, which is brought to a high temperature. This high temperature completely dehydrates the sodium silicate and bakes the wheel into a hard, solid mass. Sodium silicate cements the particles of the wheel together and does not vitrify.

Before being shipped or placed in stock, all vitrified or silicate wheels are placed in an especially designed lathe and turned to exact diameter by bringing either rotary steel or diamond dressers to bear upon their periphery.

Shellac wheels are produced by mixing carborundum or aloxite grains with powdered shellac. After the mixture is pressed into shape it is placed in a properly heated oven and allowed to remain there for several hours, during which period the wheel becomes thoroughly baked into a solid mass.

Before baking the wheels are turned true and to the proper diameter on a modified lathe



After being vitrified the wheels must be turned to the proper diameter and thickness.

During recent years it has been found that rubber, when suitably vulcanized, forms a very efficient "bond" for abrasive grains. Owing to the great pressure that rubber wheels are capable of withstanding at right angles to their plane of rotation, they are especially adaptable to certain work. The process used for producing rubber wheels is very simple. The rubber is first heated to the proper temperature, and, after abrasive grains are placed on the surface, it is made to pass under heated rolls which press the grains into the rubber. This operation is repeated several times until the abrasive matter thoroughly permeates every interstice of the rubber. Rubber wheels can be made with a diameter of 1/32 inch, owing to their great elasticity.

On a Possible Limit to Gravitation

By Frank W. Very

IT IS assumed that gravitation acts by means of longitudinal waves of alternate condensation and expansion in a universal medium, which is also a magnetic medium, or "magnetic aura," composed of least parts, or magnetons, and which is subject to magnetic laws. Hence the gravitational wave at any instant is assumed to coincide with a magnetic equipotential surface and to follow in its progressions the curves of magnetic lines of force. Reasons are given for believing that the sphere of action of a given galactic mass of stellar material does not extend to infinity, but is contained within a definite aural "cell," or is limited by the vortical motions of a particular body of the universal aura which is independent of neighboring similar bodies, possibly because there is repulsion between them, so that interference is impossible. Speaking relatively, the galaxies are rather closely packed, in total disagreement with the sparsity of stellar distribution; and the galaxies have also much greater speeds than the relative speeds of the stars which compose them; but, nevertheless, the galaxies show hardly any appearance of collision, or interpenetration—nothing which cannot be explained as variation in a general magnetic control.

In confirmation of this view may be cited van Maanen's measures of the internal motions in *Messier 101*. The motions are *away* from the center, as if controlled by currents in the general medium—that is, the motions are not such as would be anticipated under the gravitational attraction of a central mass; and the flow appears to follow a law of the inverse *cube* of the distance which would be appropriate to a magnetic control. An attempt is made in this paper to devise a scheme of an atom, or least gravitative unit, which shall be capable of performing these functions and of sustaining these relations to a general magnetic medium; and it is shown that gravitational waves having a frequency about equal to that of a light wave will account for the phenomenon, if circumscribed by a boundary; but that otherwise it is not easy to account for the action on mechanical principles. Hence it is concluded that, somewhat as the molecules of gases move in every direction among themselves, but are nevertheless controlled by the more general currents of the larger gaseous mass, so the individual motions of stars, or of the lesser star clusters are local and under the control of a more general movement of the body of aura which contains them.

According to the kinetic theory of gases, the pressure in a gas is that due to the momentum of the colliding molecules themselves as finally reflected from the containing walls of an enclosure. Without a limiting wall, the given mass of gas would expand indefinitely until its molecules ceased to collide and there would be no pressure. In a galactic mass, on the contrary, the individual stellar units do not collide, and the compression is not produced by the onward motion of the stellar "particles," or of their least component atoms; but it is produced in the containing medium by an internal mechanism within the atom itself, thus in an entirely different way. Nevertheless, as in the case of the theory of gases, it is difficult to see how there can be any *pressure* unless there is a retaining wall. Such a cell wall for the gravitational pressure is presumably a discontinuity in the aura produced by its vortical motion. Thus the aural cell may be likened to a gigantic "vortex atom."—Presented at the 21st meeting of the Am. Astronomical Society, as reported in *Popular Astronomy*.

Marine Steam Turbines and Reciprocating Engines

AT a recent meeting of the British Institute of Mechanical Engineers, in a paper on Heat Engines, Captain Sankey, R.E., said that the effect of the steam turbine upon marine reciprocating engines had been that the largest reciprocating engine now built for marine work was 4,000 horse-power, a size which was likely to still further decrease, owing to the introduction of the geared steam turbine which was now being used even for cargo boats. It is interesting to recall that in 1872 the opinion was expressed that eighty to one hundred pound steam pressure would be abandoned in favor of forty to fifty pound, owing to the difficulty of making sufficiently thick boiler plates. The story of the application of the turbine to marine work was told, and the difficulties caused by cavitation through too high propeller speeds were described. Starting with a propeller speed of 280 revolutions per minute on the Turbinia, the first vessel to be fitted with turbines, this was increased to 1,200 revolutions per minute on the Viper and the Cobra, but in subsequent ships it was dropped to 600 revolutions per minute. Later on, in the Mauretania, the propeller speed was reduced to 190 revolutions per minute, and as the speed of these large turbines was thus kept too low for economical working, the difficulty was solved in the Olympic by first passing the steam through two reciprocating engines of the ordinary marine type, each working a propeller and exhausting at atmospheric pressure into a low-pressure turbine working a third screw. The obvious arrangement, however, was to run the turbines at high speed, and by means of speed reduction gear run the propellers at their best speed. There were indications that speed reduction gear would become standard with the probability of double, instead of single, reduction.

In electric power station work, the size of reciprocating engines had been gradually reduced also, owing to the competition of the steam turbine. Today, the slow speed reciprocating engine for electric power station work was practically defunct, although the small sizes could still compete with the turbine, because the latter was not economical in small sizes. The use of geared turbines, however, was gradually overcoming this disadvantage. The increase in the size of turbines for driving dynamos had gone on until today there were units of 45,000 kilowatts, and units of 75,000 kilowatts and 100,000 kilowatts were being talked of.

The grains of abrasive material are graded according to size by passing them over inched screens of various meshes

Uniformity of Internal-combustion Motor with 6 and 8 Cylinders

THIS question is of particular interest in connection with submarine motors where the use of a flywheel is inconvenient. The author investigates the applicability of Wittenbauer's method to the case of multi-cylindered engines, and from the results obtained in specific cases he draws the following conclusions for engines of the same class as those investigated (i) Four-stroke, six-cylinder motors with two compressors need a flywheel of moderate dimensions. The arrangement of the compressors has but small influence on the regulation. (ii) Two-stroke, six-cylinder motors, with their rods at an angle of 60°, need a small flywheel. The compressors have a preponderating influence on the regulation, and their position needs careful investigation. (iii) Two-stroke, eight-cylinder motors with two compressors need no flywheel, provided all eight cylinders operate simultaneously. The compressors have a preponderating influence on the regulation, and with a suitable arrangement of these it is possible to attain a high degree of regularity.—Note in Science Abstracts on an article by E. PISTOLESI in *Accad. Sci. Torino, Atti.*

The Utilization of Condemned Army Boots*

By M. C. Lamb

In times of peace condemned Army boots were sold to contractors, who cleared all items of condemned clothing from the various barracks and camps. When war broke out and the Army grew rapidly, it was soon found that the standards of condemnation varied considerably, and an organization was therefore set up to deal with old boots. By this means no boots are prematurely condemned, and all boots that are fit for further military wear are repaired for that purpose. The remaining boots are sorted into two grades, one of which is considered to be suitable for civilian wear after repair, and the other, although occasionally purchased by clogmakers, is, generally speaking, of no further use as footwear.

With an Army of such magnitude, although every step has been taken to secure economy in footwear, there must be an increasing quantity of boots unfit for further wear. The successful utilization of this waste leather presents a very interesting problem. The Director of Army contracts, who is responsible for the disposal of Army boots, has taken a great interest in this matter, and is of opinion that a solution can be found to the problem of discovering profitable utilization.

The author has been permitted by the Director of Army Contracts to publish the results of the investigations of himself and others, including a special committee of the British Association, in this field of operations, with a view to stimulating the interest of manufacturers in this waste material.

The average composition of this discarded footwear is as follows: The total weight per pair varies from 3½ to 4 pounds, consisting of approximately 11 ounces of leather upper and 45 ounces of sole, or say 20% uppers and 80% sole. The leather employed in the soling of Army boots is practically all vegetable tanned. The leather used in the manufacture of the uppers is of vegetable origin, to the extent of about 80% of the total quantity of boots contracted for, the remaining 20% being chrome tanned. The metal used in making of the boots is approximately 19% calculated on the total weight of the boot, and consists of 18.9% of iron and 0.1% of brass; the latter is used chiefly in the eyelets.

WASTE BOOT LEATHER FOR ROAD MAKING

A promising way of utilizing this waste leather is in the making of roads. In the early part of 1910 a patent was taken out by Mr. S. Brough, of Handsworth, for a road-making material which was subsequently known as "Broughite," in which scrap leather was incorporated with slag, granite, or limestone in conjunction with asphalt and bitumen. The claim made for this material was that a road was obtained which possessed the hardness and rigidity of the ordinary tar macadam road, and at the same time reduced attrition and dust and was more resilient than the ordinary road, possessing an amount of "cushion" without liability of cracking on the surface.

The author was entrusted with the investigation into the merits of this method of road-making, and found that whilst all the reports which had been obtained upon the experimental roads which had been treated with this product were of a laudatory character and in all cases where the experiment had been tried it had been found successful, no further progress had been made, chiefly owing to the fact that the patentee had died. The Roads Board are now interesting themselves in this matter with a view to the use of leather from discarded Army boots as an ingredient in the process.

The quantity of leather used in compounding the macadam ranges from 5%, when the roadway is to be subjected to very heavy traffic, to 10% when only light traffic has to be experienced. Assuming that the average amount of leather to be employed for the purpose is 7½% of the road covering material, it will require 158 tons 8 cwt. per mile of roadway 8 yards wide. One ton of the tarred material is required for covering 6 square yards making an application 4 inches thick. Taking the average number of pairs of boots per ton at about 560 pairs, some 89,000 pairs of the worn-out product would be utilized in making each mile of the special roadway.

The method employed is simply to mix the scrap leather with the mixture of asphalt, bitumen, limestone, etc., lay the surface of the road with this composition, and afterwards give a top facing of slag, granite, or limestone.

Under the supervision of the Assistant Surveyor for Birmingham, Mr. H. H. Richardson, when District Surveyor for Handsworth, several pieces of roadway were laid. These experiments have indicated the advisability of the leather being in comparatively small pieces. The author has suggested that in the initial experiments now being carried out under the Roads Board the soles of the boots only should be used, a more profitable use for the uppers having been found. The soles should be cut into strips about one inch wide and the heels used intact, the strips from the soles being subsequently cross cut into pieces about one inch square. It is proposed, as above stated, to utilize the leather macadam mixture as a bottom dressing in making the roadway, as if used near the surface there is likely to be some difficulty owing to the fact that it would probably be too costly to remove the nails and the iron heel and toe plates before use.

The original experimental road made with "Broughite"—though laid as far back as 1910 and subsequently repaired with ordinary macadam, still retains to a considerable degree its original virtues of resilience and noiselessness under ordinary traffic conditions. It is a cheap and excellent substitute for wood paving, as in addition to possessing greater wearing qualities, and being equally silent, it costs much less than wood, and no more than bituminous macadam.

The experimental roadways provide excellent foothold for horses, as has been testified by the officer commanding the Military Riding School at Regent's Park Barracks, where an original Broughite roadway was laid in 1911; such a roadway also affords a good grip for rubber tires.

ANIMAL CHARCOAL

Of the numerous investigations made by the author, the one which from the standpoint of commercial applicability is the most promising is the use of the waste product in the mnaufacture of animal charcoal.

Animal charcoal is now almost exclusively prepared from bones as a raw product, and is in considerable demand for use in the manufacture of munitions and as a decolorizing agent for use in clarifying and decolorizing sugar, oils and fats, gelatin, etc.

On submitting the leather to dry distillation the yield of crude charcoal obtained, in repeated experiments on a fairly large scale, was found to be in the neighborhood of 35% of the total waste leather used. The resulting charcoal was boiled with dilute hydrochloric acid, treated with dilute caustic soda solution, and finally washed and dried, the result being a yield of comparatively pure charcoal equivalent in weight to about 25% of the total weight of leather distilled. The carbon so produced has been tested for its decolorizing powers on sugar syrup and gelatin, with very satisfactory results; and the product, so far as could be ascertained from the small scale experiment, was in every way quite equal to any of the ordinary commercial products made from bones.

AMMONIUM SULPHATE

The distillation products were collected in sulphuric acid and resulted in a yield of 23%—25% of crude ammonium sulphate. The maximum amount available from leather is about 28% of the weight of material used.

GREASE AND FATTY MATTERS

On analysis the leather of the uppers was found to contain on an average 15% of extractable grease and fatty matter, consisting chiefly of wool stearine, cod oil, sulphonated oil, mineral oil, tallow, and paraffin wax. The fatty mixture as extracted from a number of representative samples of the leather was in the form of a moderately hard grease, of m. pt. 37°—39° C. This product was quite suitable for use in the currying of leather or for other purposes for which a low grade of grease is desired.

The present commercial price of charcoal prepared for decolorizing purposes is in the neighborhood of £40 per ton, crude ammonium sulphate for manurial purposes £16 per ton, and solid greases from £50 to £80 per ton. The value of the yield of products may therefore be taken as follows:

1 Ton boots=560 pairs.	% lb.	Per ton.	Approx. value.
		£	£ s. d.
Metal	19·0=425	5	0 19 0
Grease and fatty matter (uppers)	15·0= 67	50	1 10 0
Purified charcoal	25·0=560	40	10 0 0
Crude ammonium sulphate	23·0=515	18	4 2 9
Total			£16 11 9

It would appear from the above figures that there is a good margin for profit in the employment of this raw material, which will be available in very large quantities, and as the process of conversion is very easy, requiring very simple apparatus, the matter should be of interest to practical charcoal burners and others, particularly in view of the fact that the raw material ordinarily employed is scarce in quantity, and not so commercially remunerative in the result; in addition, there is a considerable demand and extremely short supply of charcoal for commercial purposes at the present.

MANURE

Leather waste is sometimes employed as a manure. The manurial value of leather, owing to its extremely slow decomposition, is small unless supplied in the form of dried or finely ground powder to the soil. It should be added that chrome leather, which will not decompose under ordinary conditions, is in consequence of no use as manure. It has also been noted that chrome tanned material is harmful to plant life.

Some of the specially compounded manurial products on the market possess a small quantity of leather as an ingredient, but this has usually been treated in some way to render it more suitable for the purpose.

The fusing of the waste leather with nitre cake after removal of the iron and brass rivets or eyelets, etc., was tried, fusing one part of the leather waste with two parts of the nitre cake. The result was a dry block of manure which could be easily powdered, and which on analysis gave the following results: Ammonia 0.58% (equivalent to ammonium sulphate 2.2%). Total ammonia 1.8% (equivalent to ammonium sulphate 6.98%). This experiment was not very successful owing to the low manurial value of the resulting product, and the presence of large quantities of sodium salts.

Leather carbonized by aid of sulphuric acid is sometimes used as an ingredient in "patent' manures, and as the raw material now under discussion is cheaper than ordinary scrap leather, discarded Army boots might very well be used for this purpose.

LEATHER-BOARD

The manufacture of leather-board has been the subject matter for a considerable number of patents, but as far as the author is aware, the manufacture of this article has not met with any considerable amount of commercial success, no doubt due to the fact that formerly the price of leather of inferior grade was not sufficiently high to enable leather-board to compete with it successfully. At the present time the manufacture of leather-board for use in insoles of boots, and soles of slippers, etc., employing this cheap discarded army footwear for the purpose of pulping, appears to be more attractive than in less strenuous times.

The following suggestions have also been made:

CLOGS

Uppers of the old boots in a fair condition can be cut from the soles and nailed around wooden soles to make clogs.

WASHERS

The uppers of chrome tanned leather could be used for making washers for screw-down water taps. Experiment has shown that they possess considerable durability.

MATS

Waste leather can be used for making door-mats on the principle of chain belting.

LEATHER PULP

Pulping the leather for leather board or paper is probably practicable, but its competitor for this purpose would be the quantity of waste scraps, cuttings and machine turnings of new leather, which is more suitable to work up. The relative prices of the two materials would decide whether this would be a sound commercial proposition.

LEATHER POWDER

Leather powder for case hardening could be obtained from vegetable tanned leather by treatment with wet steam.

CYANIDES

The possibility of making cyanides has been discussed.

GLUE AND SIZE

Glue of an inferior quality could be made, the chief difficulty lying in the presence of an admixture of chrome and vegetable tanned leathers. It is possible to separate these by treatment with wet steam, and there are two processes, one of which is already patented, for obtaining glue material from chrome leather. One of these consists in treatment with sodium peroxide and the other treatment with a solution of Rochelle salt or salt of some other hydroxy-acid. At present the price of tartrates is a serious consideration, but they can be recovered almost quantitatively in the process.

*From the *Chemical News*.

Germany's Designs on French Iron Ore

THE iron and steel manufacturers in Germany form a compact and very powerful body. They act in concert with manufacturers, such as toolmakers, engine-builders, shipbuilders and the like, and their combined influence is keenly felt by the Government, which is always alert to further their interests. It will be remembered that the despatch of the "Panther" to Agadir, which sent a shiver through Europe, was prompted by the interest felt by German ironmasters in regard to the iron ore deposits in North Africa, and the desire to secure a share of them. The potent position held by the so-called heavy industries in Germany is also demonstrated by the enormous profits they have been permitted to make during the war, in spite of repeated protests from less favored manufacturers. So strong are they that they are now repudiating all suggestions of conciliating their foes, and are insisting that the terms of peace shall be drawn so as to increase very materially the existing supplies of ore within the German Empire. This point was brought forward at a recent meeting of the Union of German Iron and Steel Industries, which comprises blast-furnaces, steel works and rolling mills, bridge and wagon-building concerns, shipyards, many manufacturing engineers, iron and steel foundries, finishing works, etc., when a resolution was passed to the effect that it was necessary for Germany to retain the possession of the Briey and Longwy iron ore deposits and to insure an efficient supply of Russian iron and manganese ores.

In the report of the Union for the third year of the war reference was made to the working of the Act relating to the Civil Patriotic Auxiliary Service. It was pointed out that owing to this measure being carried out through the medium of the trade unions, it had had the opposite effect to that which was intended. The plan of the obligation to work being made compulsory had in reality been frustrated, and the banner of freedom of labor had been hoisted in the midst of the war. Many clauses of the Patriotic Service Bill really favored migration of labor, thereby helping to force up wages to a level that must cause grave apprehensions as to Germany's ability in the future to compete in the world's market.

It was further stated that the endeavors of the Union to increase productive capacity had been aided by the Social Democratic Under-Secretary of State, Dr. August Müller. The attainment of the ends in view would not only require peaceful conditions for labor, improved means of communication, the guarding of the home market against foreign competition, but also an extension of the borders of Germany to make sure of the supply of raw materials for industry. In these respects, continued the report, all other great Powers are better situated than Germany; they have plenty of bread and plenty of raw materials. The retention of the French iron ore deposits, on which the German iron industry insisted, was necessary, for the home deposits would only hold out for four or five decades. It was also important to secure a supply of phosphorus to increase the yield of the German soil. The enemies of Germany knew that without an extension of her iron ore resources she would, in another fifty years, be unable to carry on a war with her own iron.

Of no less importance was the protection through an adequate tariff of the home market against foreign competition. As regards State working or private working of industries, it was certain that the latter yielded better results, and consequently it would also, in the long run, have the greater capacity. This would, on principle, lead to the rejection of the so-called coercive syndicatizing. Reference having been made to the coal tax, the increase of the war-profit tax, the rise of the railway rates and the impending further increase of 15 per cent. on goods rates, the necessity was emphasized of these increased rates being abolished as early as possible after the conclusion of peace.

A speaker at the meeting touched upon the iron ore problem. Before the war, he said, 50 per cent. of the ore necessary for Germany's production of 16,800,000 tons of pig-iron had to be imported. In the course of forty or fifty years Germany's iron ore deposits would be about exhausted. France could perfectly well give up to Germany the necessary quantities of iron ore, without doing her own industry any harm. Russia was in a similar position. In the Krivoi-Rog basin in the Ukraine there were enormous deposits of the most ideal ore for Bessemer pig-iron, which were of the greatest importance both for the Upper Silesian and the West German iron industry. The Polish deposits could supply some 100,000 tons of iron ore annually to the Upper Silesian iron works, and the Swedish iron ore from the vast deposits in Lapland would also be of importance in the future. In addition it would be necessary for German iron works to secure their share of the extensive and valuable ore deposits in Brazil. As regards manganese ore the immense deposits in the Caucasus and other parts of Russia stood at the head of the list, and it must be remembered that for this essential commodity Germany was entirely dependent upon imports from abroad. The safe supply of iron and manganese ore must be kept in the foreground at the peace negotiations, for on this hung the continued existence of German industry, the German State and the German people.

Some time ago the original growth of this union of German Iron and Steel Industries was traced by Professor Sir W. J. Ashley before a meeting of the Staffordshire Iron and Steel Institute,* and incidentally the resources of the Briey and Longwy basins were described. The professor said that in 1879 the German iron manufacture had been undefended by customs duties for two years. The output of pig-iron was then 2.2 million tons, or rather less than in 1873. But from 1879, after the imposition of a substantial tariff, the output increased every single year down to 1890, when it reached more than 4.6 million tons. In 1893 Germany surpassed this country in the production of crude steel, turning out 3.1 million tons against Britain's 2.9. It was still behind in pig-iron production, but only 10 years were needed before, in 1903, Germany outstepped this country in iron also. In 1892-3 the syndication movement in the iron and steel industry began to achieve substantial success. In 1892 the German pig-iron producers came together, and in 1893 the Westphalian Coal Syndicate was formed. In the following years the example was followed in the various branches of the steel trade. These sectional combinations usually began with a mere price agreement; next they had to apportion the sale; and then they found it necessary to concentrate all the marketing of their commodity in a common selling organization. The most important was the syndicate of makers of ingots and billets, called the *Halbzeugverband*, or Semi-Finished Steel Syndicate. In 1904 the three syndicates just mentioned united in the Stahlwerksverband, which has commanded the position ever since. Towards the close of last year the entire output of iron and steel products of every kind had been brought together under four Central Iron Offices for war purposes.

An important part of the business of the syndicate consisted in dumping surplus stocks in foreign markets. This led to complaints that the stocks were worked up into finished products in foreign countries, and sold in neutral markets at lower prices than German manufacturers, using full-priced steel, could compete with. Then the system of bounties was inaugurated. In 1913 the bounty on exported coal and coke was raised from 1s. 6d. to 2s. 6d. per ton; that on pig iron from 4s. 6d. to 6s. 3d. per ton; that on semi-finished steel used in manufactures from 10s. to 15s. per ton, and so on. Since 1902 German exports of iron and steel have advanced, at first hesitatingly, and then by leaps and bounds. In 1910 they went ahead of those of Great Britain. The whole story, says Professor Ashley, from 1902 onward, not only indicates that the bounty system no longer puts the German user of steel material at a disadvantage in foreign markets, but also that the dumping policy, originally adopted to relieve the pressure on the home market and carry off a temporary surplus, has become the permanent policy of the German steel producers.

The fact that Germany has definitely adopted the policy of keeping her works in full operation whether the home demand be brisk or dull explains her anxiety to include within the Empire some of the ore deposits of France. To what extent she already draws on these sources is shown by an article on French Lorraine written by Dr. Schlenker, Syndic of the Chamber of Commerce, Saarbrucken, in which he stated that the annual extraction in the Briey Basin of ore containing 5 million tons of iron equalled about 67 per cent. of Germany's imports of metal, and 28 per cent. of her supply of metallic iron. The German imports of iron ore from France rose from 45,600 tons in 1901 to 2,122,000 tons in 1911 and to 3,810,000 tons in 1913. In the latter year the imports from Spain were 3,632,100 tons and from Sweden 4,558,400 tons, but both the Spanish and the Swedish ores were richer in iron than the French ores. The ore supply of Germany for 1913 was as follows:

	Ore. Tons.	Iron in Ore. Tons.
Extracted	35,941,000	10,541,500
Imported	14,019,000	7,710,400
	49,960,000	18,251,900
Exported	2,313,000	783,900
Home consumption	47,347,000	17,468,000

Hence, 44 per cent. of the contents of iron in the ore came from abroad. From France there came, as stated, 1,410,000 tons of iron, equal to 18.29 per cent. of the imports.

In view of the German designs on her ore it is no wonder that France fought so splendidly at Verdun, which is close to the coveted area. On the principle of *beati possidentes* it was worth while to make the enormous sacrifices for, as stated, by Senator Berenger, the Secretary of the National Defence Committee, "The ore basin of Briey is the battlefield on which France and Germany are fighting for the dominion of Iron." —*Engineering.*

*"The German Steel Syndicate and the British Steel Industry," by Professor Sir W. J. Ashley. Stourbridge: Mark and Moody, *County Express* Offices, High street. See also the *Quarterly Review* for April, 1917.

Poultry Culture—Perpetual Laying

INFORMATION on perpetuating layers is requested, and it is advised that method and system must be strictly followed. Next to the reliable test of a trap-nest and placing a numbered ring or celluloid circlet on pullets' or hen's legs, there is no better plan than to watch carefully the laying powers of the birds kept (especially between October and February), and to use only eggs for hatching purposes from birds whose general character as winter layers bears examination. Poultry keepers will soon learn to distinguish the good layer, for such hens or pullets will be found to be first out in the run at daybreak, and the last to roost at eventide, besides always possessing a good appetite, and being on the alert for tempting morsels of food from all sources. Generally the type of a prolific layer will be found in a medium-sized bird with short, fine, or snaky head and neck, keen eye, narrow front, with good width behind or wedge-shape in general build, legs well apart, and smart carriage. It may be added that good winter laying is largely a matter of strain, and it certainly will pay the owner of any flock of poultry to perpetuate a satisfactory strain of layers. This work may be started in a humble way by selecting two or three birds which investigation has proved to be definitely prolific winter egg-producers, preferably two-year-old hens, with trap-nested record, mated to an early-hatched cockerel, hatched from hens whose record from October to February has been 100 eggs or over. The following season the pullets hatched should be mated to the male bird, and any cockerel hatched to the parent hens, while in the following season the grand-daughters of the original male may be mated to the cockerel, and the grandson to the original hens. Such pedigree breeding is full of interest, and the records made invariably prove of great value to an aspiring poultry-breeder.

A correspondent asks if the old-fashioned Redcap fowl would be suited to a Northern district, and is advised that if the situation is fairly high and free from damp he should have good success with this most prolific breed. This correspondent contends that many of the old-fashioned breeds (such as the Dorking and Indian Game, or Hamburgh) were much in advance of some of the present-day fowls; and his statement is true in regard to certain fancy breeds, where inbreeding and mating for feather and color at the expense of eggs and flesh has been continually resorted to by fanciers. While the Redcap has preserved much of its original prolificacy, breeding for comb is responsible for a decadence observable with many strains, known in the middle of the last century as Mooneys, or Pheasant fowls. The Redcap, however, was always a reliable utility fowl, and doubtless is closely related to the golden-spangled Hamburgh. Individual records in Northern poultry-yards prove that trap-nested strains have laid 220, and even 240, eggs per annum, and these fowls (unlike most non-sitting breeds) are a source of profit for fully five and six years. They quickly put on flesh (and carry a small amount of offal), so that it is important that plenty of exercise shall be afforded them. The cockerels seldom exceed 7 pounds and pullets 5 pounds. Pullets hatched in May and June are most precocious, often laying at eighteen weeks, but this early laying should not be encouraged, as it not only conduces to small-sized eggs (unfortunately prevalent in some strains), but prevents growth and full development, most important essentials for future productiveness.

When Redcaps are crossed with the more massive Buff Orpington, good layers and fine table birds can be easily bred. It is best to use a Redcap male, and to hatch in March to obtain good results—*London Daily Telegraph.*

The Divining Rod—I*

A History of Water Witching

By Arthur J. Ellis

THE use of a forked twig, or so-called divining rod, in locating minerals, finding hidden treasure, or detecting criminals is a curious superstition that has been a subject of discussion since the middle of the sixteenth century and still has a strong hold on the popular mind, even in this country, as is shown by the large number of inquiries received each year by the United States Geological Survey as to its efficacy, especially for locating underground water, and the persistent demands that it be made a subject of investigation by the Survey. The bibliography shows that a truly astonishing number of books and pamphlets have been written on the subject. The purpose of the present brief paper is not to add another contribution to this enormous volume of uncanny literature, but merely to furnish a reply to the numerous inquiries that are continually being rectived from all parts of the country. The outline of the history of the subject presented in the following pages will probably enable most honest inquirers to appreciate the practical uselessness of "water witching" and other applications of the divining rod, but those who wish to delve further into the mysteries of the subject are referred to the literature cited in the bibliography, in which they will find reports in painful detail of exhaustive investigations and pseudo-investigations of every phase of the subject and every imaginable explanation of the supposed phenomena.

It is doubtful whether so much investigation and discussion have been bestowed on any other subject with such absolute lack of positive results. It is difficult to see how for practical purposes the entire matter could be more thoroughly discredited, and it should be obvious to everyone that further tests by the United States Geological Survey of this so-called "witching" for water, oil, or other minerals would be a misuse of public funds.

A large number of more complicated devices for locating water or other minerals are closely related to the forked twig. A favorite trick for appealing to uneducated persons and yet making specific disproof impossible is to give as the working principle of such a device some newly discovered and vaguely understood phenomenon, as, for example, radioactivity. Many such devices have been in existence since the seventeenth century, and almost without exception the claims that are made for them are very great. If any genuine instrument were invented its merits would no doubt in time become well recognized, as have those of other real inventions. The magnetic needle used in detecting iron ore is, of course, not included in this category of spurious instruments.

It is by no means true that all persons using a forked twig or some other device for locating water or other mineral are intentional deceivers. Some of them are doubtless men of good character and benevolent intentions. However, as anything that can be deeply veiled in mystery affords a good opportunity for swindlers, there can be no reasonable doubt that many of the large group of professional finders of water, oil, or other minerals who take pay for their "services" or for the sale of their "instruments" are deliberately defrauding the people, and that the total amount of money they obtain is large.

To all inquirers the United States Geological Survey therefore gives the advice not to expend any money for the services of any "water witch" or for the use or purchase of any machine or instrument devised for locating underground water or other minerals.

FORM OF THE DIVINING ROD

In its most familiar form the so-called divining rod is a forked twig, one fork of which is usually held in each hand in such a manner that the butt end of the twig normally points upward (Figs. 1 and 2). The supposition is that when carried to a place beneath which water or other minerals lie, the butt end will be attracted downward, or, according to some diviners, will whirl round and round. There are many modifications in both the form and the manipulation of the device. For instance, a straight twig may be held at the small end, allowing the butt end to bob up and down, the number of bobs being taken to indicate the depth to water or ore in fathoms or feet or other common unit of measure.

The opinion as to the kind of wood of which the twig should consist has differed greatly at different times and places, but peach, willow, hazel, and witch hazel are common favorites. By some diviners the twig is cut indiscriminately from any kind of tree, or the device is made of metal or is some common implement, such as a buggy whip. Formerly incantations

Fig. 1

were used in connection with the divining rod.

Some diviners appear to pass into abnormal or psychical states and have muscular spasms, such as occur in cases of hysteria, which, it is contended, can not be repeated at will by the diviner when he returns to a normal state. Under such conditions the twig

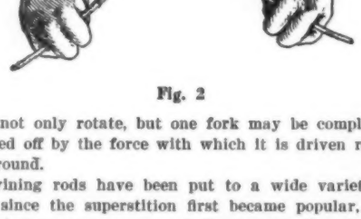


Fig. 2

may not only rotate, but one fork may be completely twisted off by the force with which it is driven round and round.

Divining rods have been put to a wide variety of uses since the superstition first became popular, and it is not uncommon even at the present time to find them used by a single person to obtain diverse results,

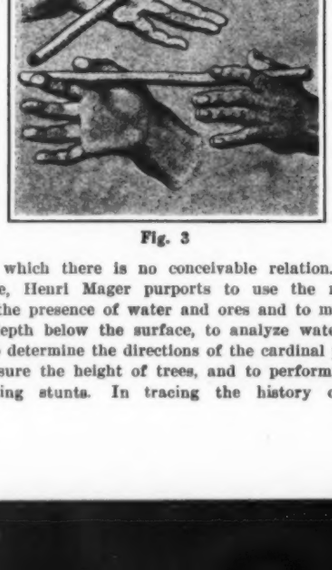


Fig. 3

among which there is no conceivable relation. For example, Henri Mager purports to use the rod to detect the presence of water and ores and to measure their depth below the surface, to analyze water and ores, to determine the directions of the cardinal points, to measure the height of trees, and to perform other interesting stunts. In tracing the history of the subject it is found that divining rods have been used for all of the following purposes: (1) To locate ore deposits, (2) to discover buried or hidden treasure, (3) to find lost landmarks and re-establish property boundaries, (4) to detect criminals, (5) to analyze personal character, (6) to cure diseases, (7) to trace lost or strayed domestic animals, (8) to insure immunity against ill fortune when preserved as a fetish, (9) to locate well sites, (10) to trace the courses of underground streams, (11) to determine the amount of water available by drilling at a given spot, (12) to determine the depth at which water or ores occur, (13) to determine the direction of cardinal points, (14) to determine the heights of trees, and (15) to analyze ores and waters.

ORIGIN OF THE DIVINING ROD

The origin of the divining rod is lost in antiquity. Students of the subject have discovered in ancient literature many more or less vague references to it, and though it is certain that rods or wands of some kind were in use among ancient peoples for forecasting events and searching for lost objects, and in occult practices generally, little is known of the manner in which such rods were used or what relation, if any, they may have to the modern device. The "rod" is mentioned many times in the Bible in connection with miraculous performances, especially in the books of Moses. The much-quoted passage describing the "smiting of the rock" (Numbers xx, 9-11) has been regarded by enthusiasts of water witching as a significant reference to the divining rod,[1] as have also the following passages: "My people ask council at their stocks, and their staff declareth unto them" (Hosea iv, 12); and "The king of Babylon stood at the parting of the way, at the head of two ways, to use divination; he made his arrows bright," etc. (Ezekiel xxi, 21.)

The following paragraphs are quoted from Rossiter Raymond's essay[2] on the use of rods for divination:

"The Scythians, Persians, and Medes used them. Herodotus says that the Scythians detected perjurers by means of rods. The word rhabdomancy,[3] originated by the Greeks, shows that they practiced this art; and the magic power of the rods of Minerva, Circe, and Hermes or Mercury is familiar to classical students. The lituus of the Romans, with which the augurs divined, was apparently an arched rod. Cicero, who had himself been an augur, says, in his treatise on divination, that he does not see how two augurs, meeting in the street, could look each other in the face without laughing. At the end of the first book of this treatise he quotes a couplet from the old Latin poet Ennius, representing a person from whom a diviner had demanded a fee as replying to this demand, 'I will pay you out of the treasures which you enable me to find.' * * *

"Marco Polo reports the use of rods or arrows for divination throughout the Orient, and a later traveler describes it among the Turks. Tacitus says that the ancient Germans used for this purpose branches of fruit trees. One of their tribes, the Frisians, employed rods in church to detect murderers. Finally, if we may trust Gonsalez de Mendoza, the Chinese, who seem to have had everything before anybody else, used pieces of wood for divination.

"Thus we perceive that the application of the divining rod in historical antiquity was mainly or wholly moral—that is, it was employed to detect guilt, decide future events, advise courses of action, etc. There are but two passages which have been quoted to prove its use for physical purposes; one from Stesias (Apud phot. bibl. cod.), who speaks of a rod of the wood Parebus, which attracted gold, silver, other metals, stones, and several other things; the other from Cicero (De Officiis, lib. I), who says, 'If we could obtain with the so-called divine rod everything pertaining to food and clothing (ad victum cultumque),' etc.[4]

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*Abstracts from Water-Supply Paper No. 416 issued by the U. S. Geological Survey, Dept. of the Interior.

[1] Latimer, Charles, The divining rod, p. 20, 1876.

[2] Raymond, R. W., The divining rod: Am. Inst. Min. Eng. Trans., vol. 11, pp. 415-416, 1883. See also U. S. Geol. Survey Mineral Resources, 1882, pp. 610-626, 1883.

[3] Rhabdomancy, from the Greek ῥάβδος, rod, and μαντεία, divination, is the practice of searching for springs, well sites, precious metals and other things concealed in the earth by means of a diving rod.

[4] This reference in complete form reads as follows: "If all that is needful for our nourishment and support arrives to us by means of some divine rod, as people say, then each of us, free from all care and trouble, may give himself up to the exclusive pursuit of study and science."

"On the other hand, the silence of many authors is significant, as Chevreul has pointed out. Varro does not mention the use of the rod for the discovery of subterranean waters or metals. Vitruvius, discussing the means of discovering springs, says nothing of it. Pliny, in Book XXX of his Natural History, omits it from his enumeration of magical arts and methods, and in Book XXXI, describing (after Vitruvius) the means of discovering springs, and Book XXXIII, describing explorations for metals, is equally silent concerning it. Columella, Palladius, and in the sixth century Cassiodorus are likewise dumb, though the latter in one of his epistles (Theodoric, LIII) extols the utility of the professional water discoverers."

Whatever significance one may attach to such references as those cited above, no conclusive evidence has been found of the use of the divining rod as it is now known earlier than the first half of the sixteenth century. What is believed to be the first published description of the rod is contained in Georgius Agricola's "De re metallica," which was begun about 1533 and was published in 1556. There is a striking similarity between some of the ideas expressed in this account and some of those now held regarding the rod and its use, which, it is believed, justify its quotation. The following paragraphs are quoted from the Hoover translation[1]:

"There are many great contentions between miners concerning the forked twig, for some say that it is of the greatest use in discovering veins, and others deny it. Some of those who manipulate and use the twig first cut a fork from a hazel bush with a knife, for this bush they consider more efficacious than any other for revealing veins, especially if the hazel bush grows above a vein. Others use a different kind of twig for each metal, when they are seeking to discover the veins, for they employ hazel twigs for veins of silver; ash twigs for copper; pitch pine for lead and especially tin, and rods made of iron and steel for gold. All alike grasp the forks of the twig with their hands, clenching their fists, it being necessary that the clenched fingers should be held toward the sky in order that the twig should be raised at that end where the two branches meet. Then they wander hither and thither at random through mountainous regions. It is said that the moment they place their feet on a vein the twig immediately turns and twists, and so by its action discloses the vein; when they move their feet again and go away from that spot the twig becomes once more immobile.

"The truth is, they assert, the movement of the twig is caused by the power of the veins, and sometimes this is so great that the branches of trees growing near a vein are deflected toward it. On the other hand, those who say that the twig is of no use to good and serious men, also deny that the motion is due to the power of the veins, because the twig will not move for everybody, but only for those who employ incantations and craft. Moreover, they deny the power of a vein to draw to itself the branches of trees, but they say that the warm and dry exhalations cause these contortions. Those who advocate the use of the twig make this reply to these objections: When one of the miners or some other person holds the twig in his hands, and it is not turned by the force of the veins, this is due to some peculiarity of the individual, which hinders and impedes the power of the vein, for since the power of the vein in turning and twisting the twig may be not unlike that of a magnet attracting and drawing iron toward itself, this hidden quality of a man weakens and breaks the force, just the same as garlic weakens and overcomes the strength of a magnet. For a magnet smeared with garlic juice can not attract iron, nor does it attract the latter when rusty. Further, concerning the handling of the twig, they warn us that we should not press the fingers together too lightly, nor clench them too firmly, for if the twig is held lightly they say that it will fall before the force of the vein can turn it; if, however, it is grasped too firmly the force of the hands resists the force of the veins and counteracts it. Therefore, they consider that five things are necessary to insure that the twig shall serve its purpose: of these the first is the size of the twig, for the force of the vein can not turn too large a stick; secondly, there is the shape of the twig, which must be forked or the vein can not turn it; thirdly, the power of the vein which has the nature to turn it; fourthly, the manipulation of the twig; fifthly, the absence of impeding peculiarities. These advocates of the twig sum up their conclusions as follows: If the rod does not move for everybody, it is due to unskilled manipulation or to the impeding peculiarities of the man which oppose and resist the force of the veins, as we said above, and those who search for veins by means of the twig need not necessarily make incantations, but it is sufficient that they handle it suitably and are devoid of impeding power; therefore, the twig may be of use to good and serious men in discovering veins. With regard to deflection of branches of trees they say nothing and adhere to their opinion.

"Since this matter remains in dispute and causes much dissension amongst miners, I consider it ought to be examined on its own merits. The wizards, who also make use of rings, mirrors and crystals, seek for veins with a divining rod shaped like a fork; but its shape makes no difference in the matter—it might be straight or of some other form—for it is not the form of the twig that matters (see fig. 3), but the wizard's incantations which it would not become me to repeat, neither do I wish to do so. The ancients, by means of the divining rod, not only procured those things necessary for a livelihood or for luxury, but they were able also to alter the forms of things by it; as when the magicians changed the rods of the Egyptians into serpents, as the writings of the Hebrews relate; and as in Homer, Minerva with a divining rod turned the aged Ulysses suddenly into a youth and then restored him back again to old age; Circe also changed Ulysses' companions into beasts, but afterward gave them back again their human forms; moreover, by his rod, which was called "Caduceus," Mercury gave sleep to watchmen and awoke slumberers. Therefore it seems that the divining rod passed to the mines from its impure origin with the magicians. Then when good men shrank with horror from incantations and rejected them, the twig was retained by the unsophisticated common miners, and in searching for new veins some traces of these ancient usages remain.

"But since truly the twigs of the miners do move, albeit they do not generally use incantations, some say this movement is caused by the power of the veins, others say that it depends on the manipulation, and still others think that the movement is due to both these causes. But, in truth, all those objects which are endowed with the power of attraction do not twist things in circles, but attract them directly to themselves; for instance, the magnet does not turn the iron but draws it directly to itself, and amber rubbed until it is warm does not bend straws about, but simply draws them to itself. If the power of the veins were of a similar nature to that of the magnet and the amber, the twig would not so much twist as move once only, in a semicircle, and be drawn directly to the vein, and unless the strength of the man who holds the twig were to resist and oppose the force of the vein the twig would be brought to the ground; wherefore, since this is not the case, it must necessarily follow that the manipulation is the cause of the twig's twisting motion. It is a conspicuous fact that these cunning manipulators do not use a straight twig but a forked one cut from a hazel bush or from some other wood equally flexible, so that if it be held in the hands, as they are accustomed to hold it, it turns in a circle for any man wherever he stands. Nor is it strange that the twig does not turn when held by the inexperienced, because they either grasp the forks of the twig too tightly or hold them too loosely. Nevertheless, these things give rise to the faith among common miners that veins are discovered by the use of twigs, because whilst using these they do accidentally discover some; but it more often happens that they lose their labor, and although they might discover a vein, they become none the less exhausted in digging useless trenches than do the miners who prospect in an unfortunate locality. Therefore a miner, since we think he ought to be a good and serious man, should not make use of an enchanted twig, because if he is prudent and skilled in the natural signs he understands that a forked stick is of no use to him, for, as I have said before, there are the natural indications of the veins which he can see for himself without the help of twigs. So if Nature or chance should indicate a locality suitable for mining, the miner should dig his trenches there; if no vein appears he must dig numerous trenches until he discovers an outcrop of a vein."

There are two accounts of earlier date than "De re metallica" which are mentioned in most histories of the divining rod. One of these accounts is contained in the "Novum testamentum" of Basilius Valentinus, a Benedictine monk of the fifteenth century, who devoted seven chapters of the second book of his work to a didactic account of the use of the divining rod. But there is some confusion as to the date and as to the authorship of this book, and Raymond points out that the existence even of Basilius Valentinus is not beyond doubt. Gadenus states, in his "Historia Erfordiensis" (1675), that Basilius was living at St. Peter's convent at Erfurth in 1413, but the earliest copy of the "Testamentum," which is a French translation in manuscript, is dated 1651, and the book was not printed until about fifty years after Agricola. The other account is contained in "De natura rerum," IX, by Paracelsus, which was no doubt written prior to "De re metallica," for Paracelsus died in 1541, but it was not published until some time later. From this account Hoover[2] quotes:

"These [divinations] are vain and misleading, and among the first of them are divining rods, which have deceived many miners. If they once point rightly they deceive ten or twenty times."

Barrett[3] considers it practically certain that the birthplace of the modern divining rod is in the mining districts of Germany, probably in the Harz Mountains, where the most approved mining processes were first devised. He says:

"Possibly they were led to its use from the belief, once universal among educated men like Melanchthon, that metallic ores attracted certain trees which thereupon drooped over the place where those ores were to be found, the drooping no doubt being due to the soil or other causes. A branch of the tree was therefore cut and held to see where it drooped; later on a branch was held in each hand and the extremities tied together; finally, for convenience, a forked branch was cut, the two ends grasped one in each hand with palms upward; the arms of the holder were then brought to the side of the body, so that the forked rod was held in somewhat unstable equilibrium, and the "diviner" set forth on his quest with, in old time, certain solemnities and invocations."

At any rate the divining rod came into common use first in Germany as a means for locating mines and also for discovering buried treasure, a matter of rather common interest in those days, when the practice of burying money and plate for safe keeping was so general.

SPREAD OF THE DELUSION

German miners were imported into England during the reign of Elizabeth (1558-1603) to lend an impetus to the industry in Cornwall, which had been passing through a period of depression. By them the divining rod was introduced into England, and before the end of the seventeenth century it had spread through the countries of Europe. Everywhere it aroused controversy. Its champions, among whom were some of the most learned men of the time, explained its operation, as, indeed, they explained nearly all facts of physics and chemistry, on the principle of "sympathy" or "attraction and repulsion." The common phenomena of gravity and magnetism doubtless suggested this interpretation. Philippe Melanchthon, in his "Discours sur la sympathie," 15—?; his son-in-law, Gaspar Peucer, in "Les devins," 1584 (book 13, ch. 10); Porta, in "Magiae naturalis," 1569 (book 1, ch. 8); Keckermann (1573-1609) in "Systemata physica" (book 1, ch. 8); and Michel Mayer, in "Verum inventum," 1619 (ch. 4), attribute the action of the divining rod to "sympathetic affinity."

[TO BE CONTINUED]

Decimal Money in England

MR. T. MCKENNA, chairman of the Executive Committee of the Decimal Association, informs us that at a recent joint meeting of the association with the Institute of Bankers and the Association of Chambers of Commerce unanimous agreement was secured as to the retention of the £ sterling as the monetary unit and its division into 1,000 parts, or mils. This enables all the existing gold and silver coins down to and including the sixpenny-piece to be retained without any alteration in their respective values. For example, the sixpence is represented exactly by 25 mils. In regard to the coins of lower denomination, it was unanimously agreed that they should consist of 1, 2, 3, 4, 5, and 10 mil pieces, of which the two latter would be of nickel. This enlarged range of the coins of lower value, in addition to providing coins substantially equal in value to the existing halfpenny and penny, would provide coins of intermediate value between the present halfpenny and penny, and thus overcome a defect in our present coinage which has resulted in prices in millions of small transactions in daily life being unduly increased because of the absence of suitable intermediate coins.—*Nature*.

[1] Agricola, Georgius, De re metallica, translated from first Latin edition of 1556 by H. C. and L. H. Hoover, pp. 38-41, 1912.

[2] Hoover, H. C. and L. H., Agricola, De re metallica, p. 38, 1912.

[3] Barrett, W. F., Soc. Psych. Res. Proc., vol. 13, p. 13, 1897-98.

Historical Sketch of Convoying at Sea*

The Protection of Sea-Borne Commerce

By Captain C. S. Goldingham, R.M.L.I.

THE protection of sea-borne commerce may be carried out by three different methods, or by a combination of all three, namely, (1) Patrolling; (2) Searching; (3) Convoying. The first consists in patrolling the threatened trade routes so closely that the enemy either dares not show himself on those routes, or if he does venture, he will in all probability encounter one of the patrolling vessels before he has time to run down and capture any merchant ship he may happen to come across, or at least before he can get his prize safely to port. As it is manifestly impossible to patrol entire oceans, it is a *sine quâ non* that prearranged routes only should be followed by the merchant vessels which are under protection. In the case of searching, the enemy's cruisers, or whatever vessels he employs to harass the commerce of the country with which he is at war, are sought out and brought to action or bottled up in their own harbors. Both patrolling and searching are rendered easier if merchant ships are despatched in groups at certain intervals in accordance with a prearranged plan, so that the friendly cruisers may know the whereabouts of the vessels they are protecting vicariously, though in this case some of the advantages of the systems as opposed to convoying, are lost through the delay occasioned in the formation of the groups. Convoying consists in the despatch of merchant ships in fleets or groups accompanied by an escort of warships. The adoption of one method in preference to another is governed by circumstances.

Trading overseas has been practised ever since men first discovered the rudiments of navigation and learnt to construct ships seaworthy enough to venture out of sight of land with impunity; and it is probably not far wrong to say that piracy has existed ever since the first fat defenceless merchant ship sailed into port with her cargo. As a means of protection for merchant shipping, however, convoying is of comparatively recent adoption. To undertake such a costly method of protecting sea-borne commerce argues a considerable volume of trade, of sufficient value to render this form of insurance worth while in order to ensure its continuance: the loss of ships through the action of the enemy, of privateers, of pirates, or whatever the hostile agent, must be such as more than to counterbalance the loss of efficiency caused to trade, due to delays in forming convoys and waiting for escorts, swamping of markets, etc., which is inseparable from convoying. It presupposes, too, a high standard of seamanship among the convoyed vessels in order that they may be able to keep company with their escort under adverse weather conditions, not an easy matter even in these days of steam.

The earliest traders were far from being the peaceful merchants of modern times. On the contrary, by the very nature of their undertakings they were explorers and fighting men, some of the finest types of their race. In early and medieval times the ship as a fighting machine was practically of no account. An exception may perhaps be made in the case of the trireme of the Greeks, who employed the armed break of their vessels as a ram for breaking up or sinking the enemy vessels. Even so late as Tudor times, which witnessed the introduction of broadside fire, soldiers were an essential part of the complement of every fighting ship. It was, in fact, man power which counted, and the early traders being what they were, they were fairly well able to protect themselves. The "Quinquireme of Nineveh from distant Ophir" was probably a match for any single pirate she might meet, though doubtless a swarm of vessels acting in concert would prove too much for her. The commerce of Phœnicia, which like that of Great Britain in modern times was largely a carrying trade, was rendered secure by the fact that the Phœnicians possessed the command of the waters where they traded for the most part, namely the Mediterranean, the Propontis or Sea of Marmora, and the Euxine, the modern Black Sea. True, they traded also to the Atlantic coasts of Spain and France and to Britain, but they were pioneers and had nothing to fear from pirates; for those were before the days of the Northmen. Under the Roman Empire the trade routes were policed by small swift vessels called *liburnae*, propelled by oars aided by square-sails, and able to run down and overcome the Phocean pirates who infested the Mediterranean. The necessity for mutual protection against the Baltic and other pirates brought about the founding of the Hanseatic League in the Middle Ages.

It is not until the fifteenth century that we hear of any regular convoy system, the first of which there is any records being the "Wafters" which safeguarded the wine and wool fleet sailing annually from the Bay of Biscay to England. During later Tudor times the appointment of "Wafter of the Wool Fleet" had grown into something resembling an hereditary office. The trade was a valuable one, for under the Moors the natural resources of Spain had been developed to a wonderful degree.

In the middle of the sixteenth century Spain was forced to adopt a system of armed escorts for the convoying of her merchant ships. For fifty years past she had been engaged in a most valuable trade with her colonies in the New World, and to such an extent had this been developed that it had become the life blood of the kingdom. The trade was the monopoly of a great company, the *Casa de Contractacion*, something after the nature of the East India Company, and was carried by a convoy or *flota*, which sailed annually to the West Indies and America, returning laden with treasure—gold, silver and precious stones—besides sugar, spices, hides and other native products. With the discovery and opening up of the Peruvian mines, towards the end of the century, a second *flota* was established, and the wealth of treasure which was annually brought home to Spain was enormous. For a long time these *flotas* sailed without escort, relying upon mutual protection afforded by sailing in company, and the guns which each galleon was supposed to carry to guard them against the depredations of corsairs. It was to the raids of the French corsairs rather than of Hawkyns, Drake and other Elizabethan adventurers that the adoption of escorts for the Indian *flotas* was due; the losses became at length so heavy that the famous Indian guard of galleons was instituted, under Pero Mendez de Aviles, Captain-General of the Indian trade, and probably the greatest seaman Spain has ever produced. The escorting vessels were the property of the *Casa de Contractacion*, provided and maintained by the company, and paid for by a tax levied on the merchants. Although not strictly royal naval ships, one may consider them as the nucleus of the navy of Spain as constructed under Philip II., a navy which in 1588 was to challenge and be defeated by the first naval Power of the world. It is an egregious error to regard Spain in the middle of the sixteenth century as a great naval power. Despite her vast and wealthy colonial possessions and the fact that integral portions of the kingdom relied solely on maritime communications, she lacked any semblance of a fighting navy; she was a military Power, the first in Europe of her day, but at sea the issue between England and Spain appears to us now, when distance enables us to view the situation in its true perspective, to have been never really in doubt. England was one of the few countries which up to that time maintained a navy for the purposes of offence and defence. Writing at the beginning of the seventeenth century, Raleigh says:

"The Kings of England have for many years been at the charge to build and furnish a navy of powerful ships for their own defence, and for the wars only. Whereas the French, the Spaniards, the Portuguese and the Hollanders (till of late) have had no proper fleet belonging to their Princes or States. Only the Venetians for a long time have maintained their arsenal of gallies. And the Kings of Denmark and Sweden have had good ships for these past fifty years.

"I say that the aforenamed kings, especially the Spaniards and Portugals, have ships of great bulk, but fitter for the merchant than for the man-of-war, for burthen than for battle. But as Popelimire well observeth, the forces of Princes by sea are marques de grandeux d'estate, for whosoever commands the sea, commands the trade; whosoever commands the trade of the world, commands the riches of the world, and consequently the world itself. Yet can I not deny but that the Spaniards, being afraid of (*for*) their Indian fleets, have built some few very good ships; but he hath no ships in garrison as his Majesty hath; and to say the truth, no sure place to keep them in, but in all invasions he is driven to take up of all nations which come into his ports for trade." (Colomb, "Naval Warfare.")

But to return to the Indian trades. Pero Menendez de Aviles was succeeded in 1588 by his son, Pero Menendez Marquez, who at once picked upon the weak points of the trade. The treasure galleons of the Indian *flota* were big, slow ships, entirely dependent for protection upon their escort. The West Indian inter-insular commerce at that time was carried by small fast vessels of the frigate class, and it was a type of vessel somewhat similar to these that Menendez determined to build for treasure carrying. They were built locally in the dockyard at Havana, which was enlarged for the purpose, and were known as *fregatas*. They mounted twenty to thirty guns, could be propelled by oars as well as sails, and could show a clean pair of heels to anything which was too strong for them to fight. They were so highly thought of that it was not permitted to send treasure home to Spain except in one of these vessels, which loaded up and sailed from Havana, proceeding independently of the *flota* and the galleons of the guard.

In addition to the Indian fleets, escorts had also to be provided for the trade with the Low Countries, at this time a Spanish province, and for the communications with Brest, which was held for the Roman Catholic League; for though the French, and afterwards the English corsairs, confined their operations mainly to the Atlantic and the waters of the West Indian Islands, Dutch pirates were rife in the English Channel.

Despite the strenuous efforts of Philip II. to form a navy, the power of England at sea more than once caused the temporary abandonment of Spain's foreign trade. In 1590 Queen Elizabeth despatched an expedition to waylay the galleons of the West Indian trade, and sooner than risk their falling into English hands, Philip ordered them to winter in the Indies. In addition to the loss to Spain caused by the stoppage for an entire year of her richest overseas trade, this had more far-reaching consequences. In those days ships' bottoms were not sheathed with copper, and the result of lying at anchor in a tropical harbor throughout the summer was that the worm got into the timbers and rendered the ships unseaworthy, with the consequence that a large number of them foundered on the voyage home in the following year. Writing of the matter in his "Naval Tracts" Monson says:

"Her Majesty beginning now to find how necessary it was for her to maintain a fleet upon the Spanish coast, as well as to hinder the preparations he might make against her to repair the disgrace he received in 1588, as also out of a hope she had to intercept his trade from the Indies, by which he grew great and mighty, and therefore of the better ability to offend her, she sent this year, 1590, twelve ships of her own in two squadrons, the one to be commanded by Sir John Hawkyns, the other by Sir Martin Frobiser, two gentlemen of tried experience and known valor. . . .

". . . (The King of Spain) likewise made a despatch to the Indies, commanding the fleets to winter there rather than to run the hasard of coming home that summer for fear of us. But this proved so great a hindrance and loss to the merchants of Spain, to be so long without return of their goods, that many broke in Seville and other places. Besides, it was so great a weakening to their ships to winter in the Indies as it was many years before they could recover their losses, as by the years following it appeared."

Nearly a hundred of the galleons were lost on the homeward voyage in 1591, says Monson. "All of which was occasioned by their wintering in the Indies, and their late disemboguing from thence; for the seas upon that coast engender a worm which doth both weaken and consume their ships."

In 1597 and again in 1598 the East Indian fleets were held up. Nevertheless the English did not have matters entirely their own way in what they termed their "infesting" of Spanish commerce, more particularly as the navy of Spain began to grow under the feverish activities of Philip II. The Elizabethan adventurers had not yet learnt that before the enemy's sea-borne trade can be attacked successfully, it is necessary to drive from the seas or to contain his fleets; and it was solely due to the comparative insignificance of the English overseas trade as compared with that of Spain, that they were able with impunity to attack the commerce of the latter. As Monson says:

"The King employed his ships to the islands, to guard his merchants from the Indies, which made

*From *The United Service Magazine.*

him have no leisure to think of England." Upon which Colomb comments, "Quite so. But if English commerce offered as important a field of attack as that of Spain, when looked at from the point of view of national importance, a Spanish attack upon English commerce would have left England 'with no leisure to think of' Spain."

In 1603 the privateers from Spain and Dunkirk had so infested the English Channel that the Queen's navy was no longer able to cope with them and ensure the safe passage of English shipping. The Royal Navy of those days was the property of the Sovereign, just as a merchant ship or group of ships might belong to any private subject, and was made to pay for itself in peace time by trading in precisely the same manner as any merchant vessel. In the trading ventures, raids or infesting expeditions against Spanish commerce—call them what you will—Queen Elizabeth frequently took a share, providing either ships or money and receiving her share of the prize money—which, incidentally, did not always give a credit balance. Her love of money led her to venture secretly when she did not dare to do so openly, during the time, for example, when England was at peace with Spain. On the outbreak of war almost the sole duty which the Navy was called upon to perform was the conveyance of troops to the Continent of Europe, for which purpose merchant ships were every whit as suitable as the Royal ships. For in Tudor times naval warfare—purely naval—was not understood. Even of the expedition of 1590, which resulted in stopping for a year the trade of Spain with the West Indies, Monson speaks as "a bare action at sea," and he attaches far more importance to the attempted landing at Fayal—which the English could not in any case have held, as witness the fact that the place was taken and abandoned by the Earl of Cumberland in the previous year. In 1603, it having grown beyond the power of the Queen's ships to protect the shipping in the Channel, on the 5th February Queen Elizabeth issued an order in council directing that money should be levied throughout the country for the provision of warships for convoy duty.

"The money so raised was not to be paid into the Treasury . . . and was to be administered, not by the Admiralty, but by a committee consisting of one deputy from each county. The Queen undertook to provide the new fleet with all munitions of war free of cost, and further that all prizes taken by it were to be enjoyed by the fund free of customs duties and Admiralty tenths. If the project did not prove to be remunerative, the committee could continue the arrangement or not as they liked. It was merely an experiment. In every way the scheme was to be made to appear purely voluntary and for the benefit of those who financed it. Her Majesty would have it known that she herself would derive no pecuniary benefit. Her sole interest in it was the security of her subjects' sea-borne trade." (Corbett, "The Successors of Drake.")

In 1650 the English were forced to provide convoys for their Mediterranean trade. The merchantman of that day required little to transform her into a warship capable of performing any warlike duty except, perhaps, fighting a duel with a heavy 50- or 60-gun galleon whose thickness of timber was bound to tell in her favor. In those days the close-hauled line of battle had not been introduced, so there was no question of the converted merchantman being forced to lie in the line with what one may term, for want of a better word, battleships. Every merchantman of those days carried guns, and could give a good account of herself in an encounter with a privateer. Against the French men-of-war, however, which in the middle of the seventeenth century were becoming daily bolder and more efficient, she could not hope to compete with success. In 1650, then, Parliament passed an act to provide money to defray the cost of a convoy service for merchantmen in the Mediterranean, which was put into operation during the winter.

Two years later the first of the Dutch wars broke out. Forty years previously Raleigh could write: "I myself may remember when one ship of Her Majesty's would have made forty Hollanders strike sail and come to an anchor. They did not then dispute *de Mari Libero*, but readily acknowledged the English to be *Domini Maris Britannici*." During these forty years, however, the Dutch had made great strides. The reasons Raleigh explains:

". . . There are five manifest causes of the upgrowing of the Hollanders and Zealanders.

"The first is, the favor and assistance of Queen Elizabeth. . . ." (No one imagined, during the reign of Elizabeth, that the English would ever have cause to regard the Dutch as serious opponents; though Raleigh himself foresaw the war, says Colomb, he did not fear it.)

"The second cause was the employing of their own people in their trades and fishing, and the entertainment of strangers to serve them in their armies by land.

"The third, the fidelity of the House of Nassau, and their services done them, especially of their renowned Prince Maurice, now living.

"The fourth, the withdrawing of the Duke of Parma twice into France, while in his absence he recovered those strong places of Friezland, Deveneter, Zutphen, etc.

"And the fifth, the embarguing and confiscation of their ships in Spain, which constrained them and gave them courage to trade by force with the East and West India, and in Africa, in which they employ 180 ships and 8,700 mariners."

The Dutch possessed at this time a valuable overseas trade, which entered their ports both via the English Channel and north about Scotland. The conclusion of peace in 1654 found them, though worsted at sea, still in a position to maintain their convoys, somewhat irregularly and at a cost, to be sure, for the British claim to have taken no less than 1,700 prizes during the two years of war.

Such a price was too heavy to pay. With the second declaration of war, in 1665, the Dutch, profiting by the experiences not only of '52 to '54, but also by the lessons of the covert attacks on their shipping, which after the manner of the times, had begun quite a year prior to the formal declaration of hostilities, resolved upon the heroic and unique measure of prohibiting for a time all overseas trade. It was clear to them that they could not afford to continue their commerce at the present rate of losses, neither could they hope to obtain the command of the sea (and so ensure the safe passage of their merchant ships) if they were forced to utilize a considerable portion of their naval forces for the protection of commerce. The right course of action appeared to them to be a concentration of ships for an attack on the British: overcome the latter, and the necessity for protecting their merchant ship convoys would automatically disappear. A secondary consideration was the fact that they could only assemble a fleet of the strength necessary successfully to attack the British by fitting out certain merchant ships as men-of-war. Severe though the blow was to the country it had at least this merit, that the enemy would be unable directly to profit by the capture of richly laden prizes. All sailings from Dutch ports were consequently forbidden, and the fisheries were closed down.

There was in this action by Holland no similarity either to that of Spain in 1590, when she ordered for a year the cessation of the Indian trade, or to that of Prussia, three centuries later, during the Franco-Prussian war, when she instructed all her merchant ships to remain in harbor rather than put to sea at the certain risk of capture by the French. In the two latter cases it was not within the power of Spain or Prussia to protect their shipping, and their course of action was consequently forced upon them. In the case of Holland, however, her action was voluntary: she was merely freeing her hands for the struggle for command of the sea.

Seventeen forty-seven, the year previous to the peace of Aix-la-Chapelle, which gave a breathing space to the French and British, provides examples respectively of how an escort should and should not carry out the duty of protecting its convoy when attacked. In June, Fox's squadron of six ships, cruising off Cape Ortugal, ran across the French West Indian convoy of a hundred and seventy vessels under the guard of four men-of-war. Instead of holding the British ships as long as possible, in order to allow the convoy to escape, the French ships, both merchantmen and men-of-war, scattered. No less than forty-eight of the merchant vessels were captured.

In David Hannay's "Rodney" a vivid picture is given of the proper method of action when attacked in superior force.

"During the summer (of 1747) the French were collecting in the Basque Roads a great convoy of outward-bound merchant ships. The English Government resolved to intercept this. . . . A squadron of fourteen sail . . . was collected at Plymouth, and placed under the command of Rear-Admiral Edward Hawke. In August Admiral Hawke sailed with orders to attack the convoy in the roadstead; but when he was on Lord Anson's cruising ground, off Finisterre, he came at daybreak on August 14th upon the French at sea under the protection of nine ships of war. There was on the English side a superiority of five ships and more than two hundred guns, but the French commander Desherbiers de l'Etenduère, decided to make a fight. The convoy was sent off under the care of the *Content*, sixty-four. Then, having weakened himself for the sake of his charge, M. de l'Etenduère made ready to sacrifice himself for it also. He formed his remaining eight ships into a line of battle across the road of the English squadron, and, keeping vigilantly on his guard, edged away after his flying convoy." Fearful of losing the French, who were to windward of him, in the dark, Hawke abandoned the conventional line of battle and ordered a general chase. "The first to come up with the enemy was the *Lion*, who at about midday, as it were, seized hold of them, and clung to their skirts till help came. It was not delayed. Other English ships swarmed up fast, each getting into action as she could, and all pressing on the Frenchmen. Six of the eight struck, but not till after hard fighting, prolonged in the case of two of them till seven in the evening. . . . At last l'Etenduère, having done enough for honor, prepared to escape with his own ship, the *Tonnant*, and the only other survivor of his squadron, the *Intrepide*." The *Eagle*, *Yarmouth*, and *Nottingham* followed in pursuit. "The *Eagle* and the *Yarmouth* were soon left behind. The *Nottingham* alone came up with the retreating Frenchmen. In this stage of the fight the odds had shifted to the other side. The *Tonnant* was an eighty-gun ship; the *Intrepide* a seventy-four. Against two such enemies the sixty guns of the *Nottingham* were too few. Captain Saumarez indeed fought until he fell mortally wounded; but the officer who succeeded him gave up the unequal conflict and at dark Hawke hoisted the signal of recall. The *Tonnant* and the *Intrepide* made their way back to port.

"It was a very pretty fight altogether, and on L'Etenduère's part a most gallant and able one. His bravery and his judgment were equally conspicuous. Not only did he save his honor, but he saved his convoy. During those seven hours of fighting the merchant ships had escaped to windward. When dark came down Hawke, with six shattered French prizes on his hands, and several of his own ships greatly damaged in hull and rigging, had nothing for it but to make his way back to England."

By the time the Seven Years' War commenced Great Britain had built up a valuable foreign trade and a correspondingly efficient convoy system. In the protection of the West Indian commerce and the North American trade lay her principal difficulties. The West Indies, where British, French, Spanish, Dutch, and disputable possessions lay close alongside one another, embraced at this time two stations, the Jamaica and the Leeward Islands stations. The convoys from North America passed through the former, which contained two alternative routes home, the Windward Passage and the Yucatan Channel. Convoys from the latter station assembled at Antigua, to the number usually of some hundred and fifty sail, and were despatched to England twice a year, in June and July: vessels leaving later than July were charged double insurance on account of the dangers of the hurricane season. The danger area was to windward of the islands, and the practice, Corbett says, was to escort the convoys as high as latitude 22 with the bulk of the Leeward Islands squadron, at which point they were considered to be out of danger, and the station ships returned, leaving the convoy to its ordinary escort. Smaller groups of ships that required convoy were dealt with in the same way.

The end of the eighteenth century found French merchant ships driven from the seas and the resources of the British navy strained to protect her own sea-borne commerce against the French privateers and others who infested the English Channel, the entrance to the Baltic, and every hole and corner of the coasts of the Mediterranean, both European and African. It was an uncomfortable time for merchant ships and a strenuous one for our frigates; for in addition to convoying, systems of patrolling and searching were used to keep the routes safe. Convoys grew to be unwieldy in size; from two to three hundred sail was quite an ordinary convoy, and sometimes even as many as a thousand merchant ships were escorted through dangerous passages in a body. All this entailed loss of time, both in collecting the convoys and also while under weigh, the speed of the convoy being that of the slowest ship and the difficulties of keeping such a mass of vessels together enormous. The escorts required were huge, for even a moderate-sized convoy of a couple of hundred sail covered a considerable area. In those days even frigates were unable easily to beat up to windward, they could barely sail within six and a half or seven points of the wind; so that if the escort fell to leeward,

an enemy vessel bearing down from windward might snatch a prize under the very eyes of the escort. Stragglers were frequent, and it was part of the duty of the patrolling vessels to pick them up and bring them into port. A serious factor was the swamping of markets by the simultaneous arrival of a large number of ships laden with similar cargoes. For this reason many owners preferred to despatch their ships independent of escort, trusting to their sailing powers and the patrolling frigates to bring them safely through. And no doubt the saving of time effected and the advantages gained by being first in the market made it worth their while, at least for merchants in a large way of business, to whom the loss of a ship was not a very serious matter. As a criterion of the relative advantages of sailing without escort or waiting for convoy one may notice that the rates of insurance differed only by five per cent. in favor of the latter, despite the fact that the insurances in those days were in the nature of twenty per cent. or more on the value of ship and cargo.

So much for the point of view of the merchants: there was, however, another side to the question, that of the Government; namely, every merchant ship captured meant the loss of a certain number of seamen; and the seaman of those days required but little training to transform him into a fighting man for the Royal service, whereas the landsman pressed for sea service required months of training. So well was the value of the merchant seaman understood, that when captured he was treated as a prisoner of war, and not as a non-combatant as he strictly speaking was. The constant drain on the available sources of supply of the Royal Navy, through the loss of merchant vessels, grew so serious that in 1798 the Government passed the Convoy Act, which prohibited the sailing of ships without escort and compelled the payment of a certain sum yearly towards defraying the cost of convoy. In the long run the scheme was beneficial not only to the country, but also to the owners themselves.

It has been stated that by the close of the eighteenth century French merchant ships had been driven from the seas. It is said that the country had actually lost half her merchant seamen—half the available source of supply for the fleet, that is to say. Her fleets no longer kept the sea, though to judge from the number of privateers annually captured or destroyed her entire maritime population must have been engaged in the game. These privateers were of every kind and description, from vessels able to put up something of a fight against a British frigate, down to mere pulling boats which operated in the neighborhood of the coasts. With a fair wind a privateer could run over during the night from one of the French ports on the Channel to the English side, make a capture, and be back in harbor again within twenty-four hours.

Under these circumstances the British navy had its hands full. "I am pulled to pieces by the demands of merchants for convoys," writes Nelson. "I wrote to the Admiralty for more cruisers until I was tired and they left off answering those parts of my letters." "I am distressed for frigates. From Cape St. Vincent to the head of the Adriatic I have only eight; which, with the service of watching Toulon, and the necessary frigates with the fleet, are absolutely not one-half enough." For the French, though their big fleets no longer kept the seas, still required watching. Mahan, in his "Life of Nelson," pictures the state of affairs in the Mediterranean.

"In this fewness of cruisers he (Nelson) was forced to keep his vessels constantly on the go—to the Levant, to the Adriatic, to Sicily, to Italy—scouring the coasts for privateers, gathering merchant ships by driblets, picking up information, and at the end of the round returning to Malta with their fractions of the large convoy. When this was assembled, a frigate or a ship-of-the-line, with one or two smaller ships of war, sailed with it for Gibraltar at a date fixed, approximately, months before. Meanwhile, at the latter place a similar process of collection had been going on from the ports of the western Mediterranean, and, after the Malta convoy arrived, the whole started together in charge of a division, composed usually of vessels of war that had to return to England for repair." One can imagine, in those days when the sole means of communication was by despatch vessels or frigates, how great were the difficulties of arranging this complicated system of convoying combined with patrolling and searching. And as if this were not enough, some of Nelson's captains appear to have thought more of feathering their own nests by making prizes than by looking after the safety of the shipping. For though the French merchant fleet was at this time non-existent, French trade was carried by neutrals. The Admiralty seem, too, inclined more than once to put in their oar, generally with the result of upsetting Nelson's arrangements. As for the convoys themselves, "They behaved, as all convoys that I ever saw did, shamefully ill; parting company every day"; these words may well apply to every convoy in those days; it was probably not so much the seamen as the ships which were at fault.

And now, after a lapse of a century, convoying has once more been resorted to; probably, too, it has never been more vitally necessary than today that it should not fail in its object of securing safe passage for the merchant vessels it is designed to protect. Its history is yet, however, too young to write.

Weakening of Photographic Prints

WHILE a great many different methods have been published for weakening or reducing photographic plates in which the image is too strong, the question of applying such a process to printing papers does not appear to have occupied much attention. But in fact most photographers have been obliged to discard numerous prints which are left too long in the sun and thus overprinted, and of course this means a waste of time and money. This is specially true when it comes to making prints from large negatives where the cost of the paper comes in as an important factor, and hence the value of a method which will allow of utilizing prints which have been exposed too long. The following method can be employed even with old prints, for in this case the print must be toned in the usual way, washed and dried. Place the print directly in the following solution: water 100 parts (by weight), hypo 10 parts, and a one per cent solution of bichromate of potash, three parts. The print begins to lighten up almost at once, and this takes place in a very regular manner. When at the right shade, remove and wash in running water. Most of the usual papers keep their original color when treated in this way, although some of them change toward a bluish violet. The above process is a good one for all gelatine papers, but for collodion papers it is best to employ the following bath which penetrates better. Here the print is not to be toned in the first place, but is washed well and then put in the bath. Water 100 parts, chloride of gold solution one part, hydrochloric acid one part. At first the image appears to stain, but in a few minutes it reduces very regularly and the toning takes place at the same time from a brick red to purple. When the print is sufficiently reduced, wash for five minutes and fix in a five per cent hypo bath. It is claimed that the tone of the print is not changed during the fixing or drying, and the prints thus treated have a fine color and are quite permanent.

The Future Development of Heat Engines

A SPEAKER at a recent meeting of the British Institute of Mechanical Engineers, in discussing the future development of heat engines generally, stated that very little improvement had been made during recent years. In other words, the practical limit had been reached. Knowledge of the laws of thermo-dynamics enabled one to say that little, if any, further improvement was possible. The best results obtained were as follows:

	B.TH.U. PER H. P. HOUR
Steam turbines	14,000
Gas engines	10,600
Diesel engines	7,700

Both gas and oil engines had reached their limit as to size, but the steam turbine could be built in much larger units than any yet attempted. Therefore, notwithstanding the considerably higher heat economy of gas and oil engines compared with the steam turbine, the latter would hold the field for large units for land and marine service, the reason being that it was a true rotary engine, and it would occupy this position until a satisfactory gas turbine had been evolved. There had been much theorizing on the subject of the gas turbine during the last fifteen years, and a few small experimental gas turbines had been built. So far, however, there had been no real progress, the main difficulty being to obtain material for the blading which would withstand the very high temperature of the impinging gas. There was also the loss due to the compression of the combustible mixture of gas and air, which loss greatly reduced the intrinsically higher thermal efficiency of the internal combustion engine, so that under the best conditions it was not likely that the practical economy of the gas turbine would be more than a few per cent better than the present gas engine. An experimental gas turbine must be of very large size, and private enterprise would not be justified in risking the large expense involved. The real object to keep in view should be the utilization of the world's fuel supplies—coal, oil and peat—to the best all-round advantage, and, to that end, increasing attention was being paid towards devising means whereby coal should not be burned to obtain heat until the by-products had been separated. The recovery of by-products would only be economical in very large plants, and the same might be said of producing electricity; it must be carried on in large stations. Consequently, it might be expected that in the future coal and peat would be gasified in producers of such a character as to recover the maximum amount of by-products, and that the remaining gas would be used for generating electric power. Generally the monetary value of the by-products was greater than that of the heat-producing element of the fuel; hence, when they had been separated it might be said that the cost of the fuel was negligible; in fact, it was the gas which was the by-product. From this, it followed that the small percentage gain in the gas turbine, could it be built, would be largely reduced in value. We were, therefore, justified in coming to the conclusion that the gas resulting after the separation of the by-products would be used under boilers for generating steam for driving large turbo-generators.

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Table of Contents

	PAGE
The Religion of the Ancient Ukraine	114
Nitrogen's Part in Nature.—By F. Rowlinson	115
Transmission of the Trematode in Venezuela	115
Desiccation of Potatoes in Germany	115
A Protective Ditch Fence.—3 illustrations	116
Our Useful Servants: Magnetism and Electricity.—By J. A. Fleming	116
Flameless Photographic Lamp	116
Periscopic or Altiscopic Rifles.—3 illustrations	117
Improvements in Zeppelin Design	117
The Causes of Disease.—I.—By Ernest S. Reynolds	118
Modern Abrasive Wheels.—By Raymond Francis Yates.—7 illustrations	120
On a Possible Limit to Gravitation.—By Frank W. Very	121
Marine Steam Turbines and Reciprocating Engines	121
Uniformity of Internal-Combustion Motor with 6 and 8 Cylinders	121
The Utilization of Condemned Army Boots.—By M. C. Lamb	122
Germany's Designs on French Iron Ore	123
Poultry Culture—Perpetual Laying	123
The Divining Rod.—1—By Arthur J. Ellis.—3 illustrations	124
Decimal Money in England	125
Historical Sketch of Convoying at Sea.—By Captain C. S. Goldingham	126
Weakening of Photographic Prints	128
The Future Development of Heat Engines	128

3, 1918

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United

s,
way,
N. Y.

PAGE
.. 114
.. 115
.. 115
.. 115
.. 116
J.
.. 116
.. 116
.. 117
.. 117
.. 118
-7
.. 120
.. 121
.. 121
8
.. 121
C.
.. 122
.. 123
.. 123
.. 124
.. 125
S.
. 126
. 128
. 128